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# ABSTRACTS

of recent published material on  
Soil and Water Conservation

Number 23

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UNITED STATES DEPARTMENT OF AGRICULTURE

"ABSTRACTS of Recent Published Material on Soil and Water Conservation" is abstracted by Charles B. Crook of Soil and Water Conservation Research Division, Agricultural Research Service.

The abstracts are issued at irregular intervals. Their purpose is to bring together a summary of current published information about soil and water conservation for ready reference for those actively engaged in soil and water conservation work. Reprints of abstracted articles are generally not available in the Division. Requests for reprints should be sent to authors or institutions--addresses have been appended to abstract.

The abstract consists principally of articles published from January 1 to June 30, 1961.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Mr. Crook is abstracting completely enough so that an article need not be consulted unless details are required. An abstract is not complete in case of a review or a "how-to-do-it" article. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to American units. Tables are included where they help to present the information. When an entire number of a publication is devoted to reviewing one subject, then the entire publication is abstracted as one article--giving title and authors of each paper included in the publication. Abbreviations of journals and addresses are the standard ones set up by the U.S.D.A. Library in U.S.D.A. Misc. Pub. 765, July 1958.

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R. S. Dyal, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland.



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## WATERSHED ENGINEERING

### Watershed Development

Engineering News-Record. WITH EIGHT AREAS PINCHED FOR WATER BY THE YEAR 2000, THERE'S A... \$200-BILLION TAG ON KERR WATER PLAN. Engin. News-Record 166(5): 21-23. Feb. 2, 1961.

The long-awaited Kerr report of the U. S. water needs through 1980, prepared by Senator Robert S. Kerr's Select Committee on National Water Resources has been sent to the White House.

The document is much more general than had been anticipated. Nearly all specifics are left for the Administration to work out. But the report does lay down a broad framework for massive water research, planning, and development that would cost close to \$200 billion in federal, state, local, and private construction by 1980. The report: (1) Stresses the need for federal-state cooperation in water programs; (2) calls for federal legislation to amplify and implement its various general recommendations; (3) asks the White House for specific evaluations of water needs and plans, and for coordination and expansion of water research programs, within specific time limits; (4) sees no dire national water shortage, except in some regions, and emphasizes that these can be met; and (5) looks to research to solve much of the nation's water squeeze.

Based on a 1954 determination that the nation's average daily stream flows total 1.1 trillion gallons, the report estimates that by the year 2000, about 81% of this water will be withdrawn from streams (888.4 billion gallons daily), but

only 23% (253.2 billion gallons daily) actually will be consumed and lost (see table). The returned flows would still be available for re-use.

The pressure for added water development, will come from a two-fold population increase by 1980 and a three-fold hike by 2000; and there will be a ten-fold increase in water-related recreation needs. About seven million acres of new irrigated lands will be needed by 1980.

#### Use of U.S. Streamflows (billions of gallons daily)

Excl. Alaska and Hawaii

	1954		1980		2000	
	With-drawals	Con-sumption	With-drawals	Con-sumption	With-drawals	Con-sumption
Irrigation.....	176.1	103.9	167.0	104.5	184.5	126.3
Municipal.....	16.7	2.1	28.6	3.7	42.2	5.5
Manufacturing.....	31.9	2.8	101.6	8.7	229.2	20.8
Thermal power cooling....	74.1	0.4	258.9	1.7	429.4	2.9
Other.....	1.5	0.3	2.7	71.3	3.4	97.6
Totals.....	300.3	109.5	558.8	189.9	888.7	253.1
% Total flow.....	27	9	51	17	81	23

#### Capital Requirements for Water Projects (billions of dollars)

	1955				1980
	Invested	Deficiency	New Needs	Obsolescence	Total Needs
FEDERAL					
Navigation.....	6.9	1.6	3.4	3.7	8.7
Flood control.....	9.5	2.8	2.3	3.0	8.1
Hydropower.....	6.6	---	5.2	2.3	7.5
Irrigation.....	3.5	---	0.7	1.6	2.3
Industrial supply.....	10.1	---	14.6	3.7	18.3
Other.....	6.9	0.4	6.4	3.0	9.8
Federal totals.....	43.5	4.8	32.6	17.3	54.7
NON-FEDERAL					
Water supply.....	70.3	4.9	46.5	30.2	81.6
Hydropower.....	6.9	---	2.4	2.4	4.8
Thermal power cooling...	3.5	---	5.9	2.1	8.0
Irrigation.....	10.0	---	1.9	4.8	6.9
Sewage & wastes.....	42.7	16.5	23.8	30.2	70.5
Other.....	2.1	---	1.3	0.6	1.9
Non-federal totals.....	135.5	21.4	81.8	70.3	173.7
Grand total.....	179.0	26.2	114.4	87.6	228.4

To meet the problem, the committee makes the following recommendations:

- (1) The Federal Government, cooperating with the States, should prepare and maintain comprehensive development and management plans for all major river basins.
- (2) The Federal Government should set up a 10-year program of financial aid to states for development of comprehensive water plans--a minimum of \$5 million yearly during the decade.
- (3) The Federal Government should set up

and coordinate a scientific water research program, and the President should submit such research plans to Congress before January, 1962, so that federal funds necessary to maintain the needed research could be placed in the fiscal 1963 budget. Research should include atmospheric physics, solar activity, groundwater movement and recharge hydrology, physical and molecular structure of water, photosynthesis, climatic cycles, desalinization, weather modification and forecasting, evaporation and transpiration reduction, waste treatment, agricultural efficiency, and fish and wildlife needs. (4) The Federal Government should prepare biennial water supply and demand outlooks for each of the 22 water resource regions. And (5) The Federal Government, cooperating with the states, should "encourage" efficiency in water use and development through flood plain regulation, immediate studies of areas where water shortages will be most acute by 1980, and studies of needs for storage reservoirs.

Costs of the program were outlined only in a general and vague manner by the committee, but it's fairly clear the Kerr group is thinking in terms of a \$200-billion construction program through the year 2000--including government and private enterprise.

Fulfillment Mgr., Engin. News-Rec., 330 W. 42d Street, New York 36, N. Y.

Anonymous. PREDICTING A WATERSHED'S FUTURE. Oreg. Agr. Progress. 8(1): 7-10. 1961.

Oregon State College is cooperating with many State and Federal agencies in a pioneering study of the whole life--past and future--of a watershed. Scientists from various disciplines are focusing their skills and training on the problems of a single typical river basin--the Alsea. The things that affect management and use of a watershed are being examined.

Results of this research will show how to develop watersheds for best domestic, industrial, agricultural, and recreational use and keep rivers healthy for fish.

Oreg. State Col., Corvallis, Oreg.

Pavelis, G. A., Johnson, H. P., Shrader, W. D., and Timmons, J. F.  
METHODOLOGY OF PROGRAMMING SMALL WATERSHED DEVELOPMENT.  
Iowa Agr. Expt. Sta. Res. B. 493: 123-160. 1961.

Physical and economic aspects of planning for the conservation and development of soil and water resources on a small watershed basis are given. Specific problems covered are: (1) Applying multipurpose concepts which have guided river basin planning in the evaluation of conservation needs and development opportunities in much smaller drainages; (2) reconciling the economic objectives and management plans of farmers who control watershed uplands with the objectives and plans of other private or public economic subunits affected by upland use; and (3) formulating optimal development programs for small watersheds, defined as programs that will maximize discounted net benefits without forcing any economic subunit to incur net losses. Empirical investigations focused on the 480-acre Nepper Watershed, which includes parts of seven farms in Monona County of western Iowa and drains into the Maple, Little Sioux, and Missouri Rivers.

Results are presented for three types of programs: (1) One of very limited scope because of severe capital restrictions; (2) one of a somewhat expanded scope, as a moderately increased expenditure was allocated optimally; and (3) a program of a scope limited only by the availability of noncapital resources or by technological restrictions.



The limited program for the Nepper Watershed with 1947 as the planning base included only land-treatment activities that would have been very profitable in providing net development benefits, whether initiated on upland or bottomland areas.

The expanded-scope type was a program devised by allocating optimally an annual expenditure of about \$3,700. This program would have yielded total annual benefits of \$11,899 and net benefits of \$8,193.

With no limit on expenditure, the program of the third type would have annually returned \$15,384 in total benefits for an outlay of \$5,716. Thus, it would have yielded a maximum of \$9,668 in annual net benefits.

Tables, maps, and graphs.

ERS, USDA, and Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Soil Conserv. 26 (9): 195-215. 1961.

This issue of the Soil Conservation magazine is devoted to Watershed development and contains the following articles:

Williams, D. A. WATERSHEDS - NATURAL UNITS FOR CONSERVATION PROGRAMS. SCS, USDA, Washington, D. C.

Jones, H. I. KIOWA SERVES AS PILOT FOR WATERSHEDS IN COLORADO. SCS, USDA, Denver, Colo.

Sloan, D. E. SICK WATERSHED GETS TREATMENT. SCS, USDA, English, Ind.

Archer, S. FLOOD PROBLEMS ON FLORIDA FLATLANDS. SCS, USDA, Spartanburg, S. C.

Kincaid, J. I. LOCAL FINANCING OF WATERSHED PROJECTS. SCS, USDA, Austin, Tex.

Walker, R. OKLAHOMA DISTRICT SPONSORS WATER SAFETY. SCS, USDA, Stillwater, Okla.

Anderson, R. S. MULTIPLE BENEFITS ON THE SHAKOPEE. SCS, USDA, Montevideo, Minn.

Harrold, L. L. HYDROLOGIC RELATIONSHIPS ON WATERSHEDS IN OHIO. ARS, USDA, Coshocton, Ohio.

Bullock, A. E. TAMING THE PIT RIVER. SCS, USDA, Alturas, Calif.

Jones, H. I. THE LADIES HELP STEER. SCS, USDA, Denver, Colo.

Guillory, J. FERTILIZING FLOOD PREVENTION STRUCTURES. SCS, USDA, Oberlin, La.

Davison, D. N., and King, V. G. SAVING AND USING THE RUNOFF. SCS, USDA, Montpelier, Idaho.

Fox, L. HANS L. VAN LEER - A PROFILE. (No address given.)

New Mexico Water Conference. WATERSHED MANAGEMENT. Fifth Annual N. Mex. Water Conf. Nov. 1-2, 1960. 97 pp. 1960.

The subject of the Fifth Annual Conference was Watershed Management. This subject was chosen because watershed management has an improvement bearing on the States' total water supply.

A yearly average of over 90 million acre feet of water falls on the 77,866,240 acres of New Mexico. This comes as rain, hail, or snow. An average of about 2.5 million acre feet enters by stream flow, which is our only other source for increasing our available supply each year.

The following papers were presented at the conference:

Ellis, G. WATERSHED MANAGEMENT RESEARCH. Cattlemen's Watershed Comm., Bell Ranch, N. Mex.

Merritt, J. L. WATERSHED MANAGEMENT BEGINS ON THE LAND. Pres., State Assoc. Soil Conserv. Dist., Yesso, N. Mex.

Brown, C. B. THE WATERSHED MANAGEMENT PROGRAM OF THE U. S. DEPARTMENT OF AGRICULTURE. Asst. Adm. Watershed Div., SCS, Washington, D. C.

Kassander, A. R. SEEDING OF SUMMER CUMULUS CLOUDS. U. Ariz., Tuscon, Ariz.

Keppel, R. V. SOME RESEARCH FINDINGS ON THE ALAMOGORDO CREEK EXPERIMENTAL WATERSHED. SWCRD, ARS, USDA, University Station, Tuscon, Ariz.

Reynolds, H. G. VEGETATIVE MANAGEMENT FOR WATER YIELD IN THE SOUTHWEST. FS, USDA, Ariz. State U., Tempe, Ariz.

McColm, A. L. PHYSICAL AND SOCIAL PROBLEMS IN WATERSHED MANAGEMENT. U. Ariz., and Pack Found., Tucson, Ariz.

Love, L. D. MANAGEMENT OF ALPINE AND SUBALPINE MOUNTAINOUS AREAS FOR WATER YIELD. FS, USDA, Fort Collins, Colo.

Dortignac, E. J. THE RIO PUERCO - PAST, PRESENT, AND FUTURE. FS, USDA, Albuquerque, N. Mex.

Whitworth, J. W. RESEARCH ON THE CONTROL OF SALT CEDAR AT NEW MEXICO STATE UNIVERSITY. N. Mex. State U., University Park, N. Mex.

Lowry, O. J. PHREATOPHYTES IN REGION 5. Bur. Reclam., U. S. Dept. Int., Amarillo, Tex.

Arle, F. SALT CEDAR CONTROL WITH CHEMICALS. ARS, USDA, Phoenix, Ariz.

Arnold, J. F. THE ARIZONA WATERSHED PROGRAM. Ariz. Land Dept., Phoenix, Ariz.

Forsling, C. L. WATERSHED MANAGEMENT TO INCREASE WATER YIELD. Pack Found., Albuquerque, N. Mex.

Stucky, H. R. WATER AND PEOPLE IN NEW MEXICO. N. Mex. State U., University Park, N. Mex.

Miller, A. L. WATER NEEDS OF TOMORROW. Off, Saline Water, U. S. Dept. Int., Washington, D. C.

Reynolds, S. STATE WATER PROGRAM. State Engin. Sante Fe, N. Mex.

Campbell, J. REPORT ON GOVERNOR'S WATER RESOURCES COMMITTEE. Governor's Water Resources Comm. Rosewell, N. Mex.

Aston, R. SALINE WATER PROJECT ROSEWELL - DEVELOPMENT. South-spring Found., Rosewell, N. Mex.

Woodbury, C. M. WHAT THE SALINE WATER CONVERSION PLANT MEANS TO THE CITY OF ROSEWELL, NEW MEXICO. City Manager, Rosewell, N. Mex.

Jones, D. J. RIO DE PENASCO WATERSHED PROJECT. U. S. Park Serv., Sante Fe, N. Mex.

N Mex. State U., Milton Student Cent., University Park, N. Mex.

McBroom, J. T. FISH AND WILDLIFE IN SMALL WATERSHEDS. J. Soil and Water Conserv. 16: 21-24. 1961.

When the original Watershed Protection and Flood Prevention Act was signed into law in August 1954, it was well received by most fish and wildlife conservation interests. Public Law 566 seemed to offer considerable opportunity for benefits to fish and wildlife habitat within the framework of improved land use and water management measures.

This initial optimism was borne out by experience during the first 2 years of its operation. As watershed work plans became available for analysis, it was apparent that some of them contained water management features most favorable to fish and wildlife. Many soil conserving practices recommended also improved wildlife habitat. In other cases, measures recommended in work plans were more or less neutral in their immediate effects on fish and wildlife. These offered promise for the future in that they would provide a stable land-use base to which more specialized fish and wildlife management measures could later be applied. Only a few work plans--less than 5 percent--proposed measures that would have serious adverse effects on fish and wildlife resources, and these largely by drainage of wetlands.

There will be many instances in the course of the watershed program where projects will have potential benefits for fish and wildlife. Some of these may not be of such size or location as to be attractive to State fish and game departments or else the departments simply may not have sufficient funds to undertake every such development. Under the cost-sharing provisions, many developments may be well within the economic reach of local sportsmen's groups, civic organizations, watershed districts, counties, towns, or others. There should be many other instances where small, public-spirited groups can acquire the necessary easements in cooperation with the sponsoring organizations or contribute a share of the construction cost thereby securing for their community a worthwhile public fishing or hunting area.

The Small Watershed Program, with the legal tools available, can fulfill its early promise as one of the best fish and wildlife programs sponsored by the Federal Government if we use its provisions wisely.

Chief, Div. Tech., Serv., Bur. Sport Fisheries and Wildlife, U.S. Dept. Interior, Washington, D. C.



National Reclamation Association and the National Association of Soil Conservation Districts. PROCEEDINGS OF THE NATIONAL WATER RESEARCH SYMPOSIUM. March 28-30, 1961 in Washington, D. C. 87th Congress, 1st Session. . . . . Senate Document No. 35. 238 pp. 1961.

The National Water Research Symposium, sponsored by the National Reclamation Association and the National Association of Soil Conservation Districts, was called for the purpose of acquainting the general public with the seriousness of the national water problem and focusing attention upon the need for a more adequate research program.

The 53 papers presented at the meeting are given. The speakers represented the highest technical and administrative confidence in the field. Dr. Byron T. Shaw, Administrator of the Agricultural Research Service, presented the key-stone address - DISCOVERY - THE JOB OF RESEARCH. The following five subjects were given by panel discussion: (1) Water demand; (2) water supply; (3) efficient use of water in nonirrigated agriculture; (4) efficient use of water in irrigated agriculture; and (5) multiple use of water resources.

Wayne M. Akin, Co-Chairman of the Symposium Committee, summarized the significant accomplishments of the meeting as follows:

1. Research is the key to solving our water and land problems or reducing them--and has an unlimited potential.
2. The capacity of research to solve the Nation's water and land problems is directly proportional to the effort and financial support given it.
3. This symposium and the related governmental investigations have documented the fact that research directed toward water and land problems is now critically inadequate.
4. The basic administration of water and land research should be transferred to an independent agency unrelated to production research.
5. The head of this agency should be on such a level administratively so that he would report directly to an assistant secretary. This would ensure budgetary consideration in proportion to the importance of the subject.
6. Immediate action should be taken to bring water and land research up to a level commensurate with the urgency of the need for the conservation and development of these resources throughout our country.

U.S. Govt. Printing Off., Washington, D. C.

Pough, R. H. LOWLANDS ARE THE HEART OF A WATERSHED. Va. Wildlife 22 (2): 7. 1961.

Respect for the integrity of a watershed as it has been carved by the forces of nature should be the key to its management. The contours of the land and the character of the natural bodies of temporary and permanent water that occupy a watershed represent a dynamic equilibrium. The factors involved in such an equilibrium are: (1) Rainfall, especially the large amounts that can occasionally fall over rather short periods; (2) the ratio of in-soak to run-off on various parts of the watershed; and (3) the balance between the temporary storage capacity of swamps and marshes and the capacity of the stream channel to carry off water.

Marshes and swamps act as "safety valves," filling with water during periods of peak rainfall--water which they slowly and automatically feed into the river as it rids itself of its overload and its level falls. Where many such "safety valves" were part of the original equilibrium, river channels are never very deep or wide, as the run-off from even a heavy storm could be handled with only a moderate increase in stream flow.

The urbanization of a watershed's upland drastically reduces its in-soak and increases its run-off over what it was when nature was carving the channels

occupied by its streams. It is an inherent characteristic of dynamic equilibria that when one factor is changed, compensating changes must occur. If run-off is increased, either a stream's channel must be deepened and its flood plain widened or the temporary storage capacity of its swamps and marshes increased.

Now that man has largely taken over responsibility for the reshaping of water courses, he must do one or the other. Increased storage takes place automatically as every inch a stream rises results in the absorption of many millions of gallons of water by its swamps and marshes before a further rise can occur. A 6-inch rise on a 10-acre marsh puts over a million and a half gallons into storage.

Any attempt to solve the problem of increased run-off by local channel enlargement is anti-social. It only shifts the burden of handling the extra water on those downstream, aggravating problems they already face. A sound solution is to retain and, if possible, increase the temporary storage capacity of every swamp and marsh.

The purchase of swamps and marshes and flood plain areas subject to frequent flooding is invariably far cheaper than channel deepening or widening, and the enlargement of their temporary storage capacity is inexpensive and involves little or no maintenance.

No address given.

## Hydrology

McGuinness, J. L., Harrold, L. L., and Amerman, C. R. HYDROGEOLOGIC NATURE OF STREAMFLOW ON SMALL WATERSHEDS. J. Hydraul. Div., ASCE 87 (HY 1): 1-13. Jan. 1961.

The importance of watershed area in depth-area-duration-frequency relationships on streamflow from small watersheds was investigated. Size of area was found to be an index of geologic and geomorphologic properties of the watersheds. Area index was related to annual streamflow and also to flows of as short as 2- or 8-day duration. A reconnaissance survey of base flow and a preliminary geologic investigation in one of the watersheds helped clarify the interrelationships between the geologic and hydrologic aspects of the study.

SWCRD, ARS, USDA, Coshocton, Ohio.

Kohout, F. A. CYCLIC FLOW OF SALT WATER IN THE BISCAYNE AQUIFER OF SOUTHEASTERN FLORIDA. J. Geophysical Res. 65: 2133-2141. 1960.

Observations over a period of nearly 20 years confirm the fact that the salt-water front in the Biscayne aquifer along the coast of the Miami, Florida, area is dynamically stable at a position seaward of that computed according to the Ghyben-Herzberg principle. During periods of heavy recharge, the fresh-water head is high enough to cause the fresh water, the salt water, and the zone of diffusion between them to move seaward. In addition to this bodily movement of the system, there is a seaward flow of diluted salt water in the zone of diffusion. When the fresh-water head is low, salt water in the lower part of the aquifer intrudes inland, but some of the diluted sea water in the zone of diffusion continues to flow seaward. Cross sections showing equipotential lines in terms of equivalent fresh-water head show that the sea water flows inland, becoming progressively diluted with fresh water, to a line along which there is no horizontal component of flow, after which it moves upward and returns to the sea. The cyclic flow acts as a deterrent to the encroachment of sea water because of return to the sea of a part of the inland flow.

U.S. Geol. Survey, Miami, Fla.



Morris, S. B. OUTLOOK FOR ECONOMIC USE OF FRESH WATER FROM THE SEA. J. Irrig. and Drain. Div., ASCE 87 (IR 2): 15-26. June 1961.

The need and market for fresh water from the sea or from inland saline waters are mainly dependent on the cost of producing such water, storing, and transmitting it to places of use in competition with other sources of fresh water supply.

Foreseeable costs of conversion far exceed prevailing costs of major domestic, industrial, and irrigation water supplies. Typical costs are presented for municipal, industrial, and irrigation supplies and for current and foreseeable costs of fresh water conversion. Comparison is made of water availability and requirements in the humid Eastern United States and the semiarid Western United States.

In the United States, it would appear that there will be no substantial need or opportunity for such plants along the Pacific coast. A need for these plants may develop along the Texas Gulf coast when the lower-cost natural waters are fully utilized. Inland in the 17 Western States, there will develop a great need for additional sources of water, and there are substantial quantities of saline waters. This is an area where agriculture, especially irrigated agriculture, has a prominent or predominant role in the present economy of each State. As natural fresh waters become fully developed, it will be difficult for agriculture on a price basis to compete with urban and industrial demands for water. Any solution offered by production of fresh water from saline waters would have to be within the ability of the irrigator to pay. It would appear that high-cost disposal of waste saline-process waters may offer an added problem in the use of inland saline waters as a source of fresh water.

Conserv. Engin., Los Angeles, Calif.

Sharp, A. L. Gibbs, A. E., Owen, W. J., and Harris, B. APPLICATION OF THE MULTIPLE REGRESSION APPROACH IN EVALUATING PARAMETERS AFFECTING WATER YIELDS OF RIVER BASINS. J. Geophysical Res. 65: 1273-1286. 1960.

The efficacy of the use of the multiple correlation and regression approach in evaluating parameters affecting water yields of river basins is examined. Results of several analyses of annual and monthly streamflow of the Delaware River Basin in Kansas are presented to provide a background for an examination of the method. Hydrologic data, in general, and factors affecting water yield, in particular, may not fit the premises upon which the multiple regression method of analysis is based because: (1) There are no errors in the independent variables; errors occur only in the dependent variable; (2) the variance of the dependent variable (streamflow) does not change with changing levels of the independent variables (precipitation, for example); and (3) the observed values of the dependent variable are uncorrelated random events.

Hydrologic data may not fit the further assumption implicit in tests of significance of multiple correlation and regression coefficients, that is, that the dependent variable (streamflow) is normally distributed about the regression line for fixed levels of the independent variables under consideration.

It is concluded that: (1) Although the multiple regression approach will result in a line of best fit and best estimating equation for hydrologic data, it is not safe to place too much reliance on values estimated by such equations, particularly at levels far removed from the mean, despite very high correlation coefficients; and (2) some of the more modern statistical procedures may be better tools than the multiple regression approach for evaluating effects of watershed parameters on water yield.

SWCRD, ARS, USDA, Lincoln, Nebr.

Hantush, M. S. MODIFICATION OF THE THEORY OF LEAKY AQUIFERS.  
J. Geophysical Res. 65: 3713-3725. 1960.

The theory of leaky aquifers as currently known involves among other things the assumption that the storage in the semipervious layers is small and may be neglected. Frequently, the semipervious beds, although of very low permeabilities, may yield significant amounts of water from storage. Flow systems in which the storage in the semiconfining layers was taken into consideration is reported. These general solutions gave a more exact description of the actual flow system.

N. Mex. Inst. Mining and Tech., Socorro, N. Mex.

Gorham, E. FACTORS INFLUENCING SUPPLY OF MAJOR IONS TO INLAND WATERS, WITH SPECIAL REFERENCE TO THE ATMOSPHERE. Geol. Soc. Amer. B. 72: 795-840. 1961.

Sources of ion supply to natural inland waters include not only rocks and soils but also the atmosphere, whose significance has been underestimated. Atmospheric materials are transferred to surface waters by rain or snow, as dry fallout, or in gaseous form; the sources are the sea, land surfaces, volcanoes, products of air pollution, or organic debris. Ion supply by soil and rock weathering, which is usually more important than atmospheric supply, involves solution, oxidation-reduction reactions, activity of hydrogen ions, and complex formation. Transfer from soils to waters is influenced by ion exchange and by modes of water percolation.

Five principal environmental factors--climate, geology, topography, biota, and time--interact to determine ionic concentration and composition of atmospheric precipitation, soil solutions, and lake and river waters, although the extent to which each applies is not well understood. Investigation of situations in which only a single factor varies effectively should do much to clarify the role of each in determining the ultimate composition of natural waters.

Botany Dept., U. Toronto, Toronto, Canada.

Thames, J. L., and Ursic, S. J. RUNOFF AS A FUNCTION OF MOISTURE-STORAGE CAPACITY. J. Geophysical Res. 65: 651-654. 1960.

Amount of rain and available storage in the soil before the rain were two major influences on the amount of surface runoff. The amount of water held in the 0- to 6-inch soil layer provided a practical index to the antecedent-storage condition of the soil profile. The study suggests that reasonably accurate predictions of storm runoff can be computed from rainfall data, if reliable estimates of the available storage in the top 6 inches of soil are made.

Runoff predictions using the 0- to 6-inch soil storage index were most accurate for winter periods and least accurate for high-intensity storms.

SWCRD, ARS, USDA, Lompoc, Calif.

Harrold, L. L., and Roberts, R. L., Jr. WINTER RUNOFF FROM SNOW AND FROZEN GROUND. Mich. State U. Q. B. 43(1): 154-170. 1960.

In 1940, a research project, designed to study and evaluate the important factors in snow and frozen ground hydrology, was established at Michigan State University, East Lansing, Mich. Two cultivated watersheds were extensively instrumented along with one wooded watershed.

The area of each of the three watersheds is about 2 acres. The aspect of the two cultivated watersheds (A and B) is N-NW. The average slope of watershed

A is 6 percent and that of watershed B is 6.5 percent. The soils of the watersheds are well-drained fine sandy loams and loamy fine sands of glacial origin. Both watersheds were basically in a rotation of corn with cover crop, oats, and 2 years of hay.

The data and discussion in this report constitute a simple graphical presentation of basic summaries of some measured factors, which are believed to influence precipitation-runoff relations during periods of freezing and thawing of the soil mantle and accumulation and melting of snow. The relationships among the factors shown on the graphs are not simple.

It is possible that there are unknown and unmeasured factors that would help to explain some of the phenomena. It is possible that the precision of the measurements was not sufficiently refined to allow rigorous analysis of the relationships involved. The runoffs that occurred on January 14, 1947, and February 12-13, 1949, indicate the difficulties that are encountered in the measurement of snow-water storage and snowfall. At both times the runoff was greater than the indicated available water.

Differences that seem to be explained by one variable (cover) are shown by the runoffs of April 5, 1947. On that date, over 2.5 inches of rain fell on a thawed surface underlain with frozen soil on both watersheds. Runoff from A (corn stubble with rye winter cover) was about 1.8 inches, compared with less than 0.6 inch on B (alfalfa-brome). March 19, 1948, indicates the effect of two variables (cover and occurrence of frost). The soil on watershed A (alfalfa-brome) was not frozen, but on watershed B (corn stubble with rye winter cover) there was a surface thaw underlain with frozen soil. A rain of 2.5 inches caused a runoff from A of about 0.6 inch and from B, over 2 inches.

January 18-19, 1949, and March 31, 1949, point to the effect of some unmeasured factor. In January, over 1.5 inches of rain and sleet fell with runoffs from both watersheds of over 1 inch, but in March, over 1.5 inches of rain and snow fell with no runoff from A and very little from B. On both dates the soil was not frozen and the soil moisture content was similar.

Special attention is now being given to the comprehensive interpretation of the temperature, solar radiation, frost zone, runoff, and other related data collected at the East Lansing project over the years. Efforts are also being made, in continuing the data collection activities, to record the various factors with more precision and with better continuity.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Ursic, S. J., and Thames, J. L. EFFECT OF COVER TYPES AND SOILS ON RUNOFF IN NORTHERN MISSISSIPPI. J. Geophysical Res. 65: 663-667. 1960.

Hydrologic and meteorologic data for individual storms were collected from small headwater catchments representing three types of cover in northern Mississippi during 1958. Surface runoff and peak flows were greatest from abandoned fields, intermediate from depleted upland hardwood forests, and least from 20-year-old loblolly pine plantations that had been established on eroding farm land. The pine cover has been a highly effective flood-abatement measure.

The soils are silt loams of loessial origin and Coastal Plain sandy loams. Surface runoff from each of the three types of cover increased directly with the proportion of loessial soil. A shallow fragipan more than doubled the amount of surface runoff and increased peak flows. Detention storage above the fragipan was directly related to flow stage at the flume.

South. Forest Expt. Sta., FS, USDA, Oxford, Miss.



Cooper, C. F. CONTROLLED BURNING AND WATERSHED CONDITION IN THE WHITE MOUNTAINS OF ARIZONA. J. Forestry 59: 438-442. 1961.

The effects of controlled burning on watershed condition in the ponderosa pine zone were studied on the Fort Apache Indian Reservation in Arizona. Soil exposure and soil movement were significantly increased by burning, but there was no evidence of removal of as much as one inch of soil. Most eroded material merely moved a short distance down slope, and the soil was essentially stabilized 9 months after burning.

Burning reduced humus accumulation beneath pine stands from about 61,000 pounds per acre to 52,000 pounds. The physical appearance of the remaining humus was altered by fire. There was no significant difference in waterholding capacity of burned and unburned humus.

Although vegetation density on the watershed has increased due to restriction of natural fires, it is doubtful if controlled burning of the intensity now being practiced will reduce the total quantity of vegetation enough to affect streamflow materially. The over-all influence on watershed condition of controlled burning as currently being carried out on the Fort Apache Reservation is relatively slight.

SWCRD, ARS, USDA, Boise, Idaho.

Knudson, H. T., and Hamann, D. D. NEW PASTURE FURROWER MEETS CONSERVATION NEEDS. S. Dak. Farm and Home Sci. 12(2): 17-19. 1961.

A pasture furrower is described and illustrated that has been used in South Dakota with good success on native and blue grass pastures.

The machine makes the furrows without destroying the sod.

The furrows should be made when soil moisture conditions are relatively high. A packer or heavy roller should be pulled behind the furrower.

S. Dak. Agr. Expt. Sta., Brookings, S. Dak.

## Geology

White, E. M. DRAINAGE ALIGNMENT IN WESTERN SOUTH DAKOTA. Amer. J. Sci. 259: 207-210. 1961.

Northwest-southeast stream alignment in western South Dakota coincides with the prevailing wind direction. This alignment appears to be due to the periodic accumulation of locally derived eolian sediments in drains which are not aligned. Because of this deposition, unaligned drains are not elongated by water erosion as rapidly as those which are aligned. Eolian sediment can be derived locally and deposited when the prairie vegetation is destroyed by fire or weakened by drought.

S. Dak. State Col., Brookings, S. Dak.

Lindsey, A. A., Petty, R. O., Sterling, D. K., and Van Asdall, W. VEGETATION AND ENVIRONMENT ALONG THE WABASH AND TIPPECANOE RIVERS. Ecol. Monographs 31: 105-156. 1961.

The flood plains studied extend along the Wabash and Tippecanoe Rivers for 430 miles of stream distance, and range through 230 miles of latitude. The glacial and post-glacial history of the region has been of major importance in determining present watershed characteristics. The coarser texture of Tippecanoe

substrates, the much more regular stream flow, the much larger size of the Wabash River, and the climatic consequences of the latitudinal difference, provided the principal background for vegetational characteristics.

Samples of alluvial soil were analyzed for mechanical composition, organic matter content, pH, moisture equivalent, permanent wilting percentage, and growth water storage capacity. Although there is a tendency toward finer textured flood plain soils from upstream to downstream, the soil factor appeared to be more uniform than the other important habitat factors of plants there.

Environmental and botanical observations on 629 vascular plant species were recorded. Estimations of heights of plants above or below the current water levels were translated into heights of plant stem-bases above or below the average water level at that point on the river. This mean is the only comparable basis for plants growing at different latitudes along the north-south stream flow gradient, and was determined from mean monthly discharge records and gage height-discharge rating tables of the U. S. Geological Survey. Adjusted estimations were analyzed to find the relation of each species to the average water level on the Wabash flood plain than on the Tippecanoe. The Wabash has more frequent as well as greater fluctuations. Some species occur close to the average water level on both rivers.

A medium-sized island, largely built by a single major flood 15 yrs. ago, now supports both cottonwood and black willow up to 13 in. d.b.h.

Typical physiographic categories of these flood plains are the aquatic, the water margin, backwater pockets, insular bars, point bars, cutbanks, the flood plain proper, and flood plain depressions. A far greater expression of aquatic vegetation was found in the Tippecanoe than in the Wabash.

Purdue U., Lafayette, Ind.

Meyer, A. F. EFFECT OF TEMPERATURE ON GROUND-WATER LEVELS.  
J. Geophysical Res. 65: 1747-1752. 1960.

The results of laboratory experiments and field investigations in Minnesota and Nebraska are presented to show that ground-water levels fall from 1 to 2 feet during the winter, with reduction in air temperature, and rise approximately the same amount in spring with increased air temperature. This condition was found to prevail in different soils during periods when there was neither evapotranspiration nor deep seepage to account for the observed change in ground-water levels. In the areas studied, both surface topography and ground-water topography showed very flat slopes. In fact, the water table was almost level.

The observations apply to areas of relatively shallow water table.

Daily fluctuations of ground-water levels in Nebraska due to evapotranspiration and temperature are graphed. Daily fluctuations of 1 to 7 inches were recorded during the month of July.

Consulting Hydraul. Engin., Minneapolis, Minn.

Maasland, M. WATER TABLE FLUCTUATIONS INDUCED BY INTERMITTENT RECHARGE. J. Geophysical Res. 64: 549-559. 1959.

The problem of water table fluctuations in response to repeated recharges is considered. The effect on the water table on intermittent constant recharge (recharge applied intermittently at a constant rate) and of intermittent instantaneous recharge (recharge applied instantaneously at regular intervals) is analyzed in detail. The final results are shown to consist of a combination of periodic and transient components; the transients are monotonic decreasing functions.

The theory may be applied to problems of ground-water flow through aquifers and to land drainage problems.

Bur. Reclam., U. S. Dept. Interior, McCook, Nebr.

## Engineering Design

Kennedy, J. F. STATIONARY WAVES AND ANTIDUNES IN ALLUVIAL CHANNELS. Calif. Inst. Tech. Rpt. No. KH-R-2, 146 pp. 1961.

A theoretical and laboratory investigation was made of antidunes and associated stationary waves. The objectives were to determine the factors involved in the formation of antidunes, the characteristics of the stationary waves, and the effects of antidunes and waves on the friction factor and sediment transport capacity of streams.

In the potential flow solution for flow over a wavy bed it was hypothesized that the flow shapes the erodible sand bed by scour and deposition to conform to a streamline of the flow configuration for which the energy is a minimum. Under this hypothesis, flow over antidunes is the same as the segment of flow above an intermediate streamline of the fluid motion associated with stationary gravity waves (waves with celerity equal and opposite to the flow velocity) in a fluid of infinite depth. In the following formula:  $L = \frac{2\pi V^2}{g}$ ,  $g$  denotes the acceleration due to gravity,  $V$  denotes the velocity, and  $L$  denotes the wavelength. When this formula is used, waves break when their height reaches 0.142  $L$ . Laboratory and field data for two-dimensional stationary waves and antidunes confirmed these relations. For the same velocity, short-crested, three-dimensional waves (rooster tails) have shorter wavelengths than two-dimensional waves.

Forty-three experimental runs in laboratory flumes were made for different depths and velocities and bed sands of two different sizes (0.549 mm. and 0.233 mm.). No general criterion for the formation of antidunes or the occurrence of breaking waves could be formulated because of inadequate knowledge of the complex sediment transport phenomenon. Qualitatively, it was found that for a given sand, the critical Froude number for the occurrence of breaking waves decreased as the depth was increased. Over a certain range of depth and velocity it was found that the flow formed waves and antidunes or was uniform depending on whether or not the flow was disturbed to form an initial wave. Waves that did not break had no measurable effect on the transport capacity or friction factor, but breaking waves increased both of these quantities.

W. M. Keck Lab. Hydraul. and Water Resources, Calif. Inst. Tech., Pasadena, Calif.

Kennedy, J. F. FURTHER LABORATORY STUDIES OF THE ROUGHNESS AND SUSPENDED LOAD OF ALLUVIAL STREAMS. Calif. Inst. Tech. Rpt. KH-R-3, 36 pp. 1961.

A laboratory study was made to determine the variation with depth and velocity of the hydraulic and sediment transport characteristics of a constant-discharge flow. Eight experimental runs were performed in a 60-foot long, 33.5-inch wide recirculating laboratory flume. The unit discharge for all runs was 0.50 c.f.s. (cu. ft. per sec.) per ft. and the velocity was varied from 0.91 to 2.21 f.p.s. (ft. per sec.), corresponding to a change in depth from 0.550 to 0.228 ft. The bed sand used for these experiments had a geometric mean sieve diameter of 0.142 mm. and a geometric standard deviation of 1.38.



As the velocity was increased, the bed form changed from a dune-covered configuration to a flat bed, with sand waves occurring at intermediate velocities. It was found that for the unit discharge and bed sand, two different velocities and sediment transport rates are possible for a given slope, or a given bed shear velocity; however, this multiplicity is possible only in the range of slope and shear velocity where major changes in the bed configuration occur since it is a result of large variations in the bed roughness. The slope or shear velocity cannot logically be used as an independent variable since neither of these quantities uniquely determines the velocity or transport rate. However, if the velocity is used as the independent variable for a constant-discharge flow, the slope, shear velocity, and friction factor are all uniquely determined. The sediment transport rate was found to be a single-valued, uniformly increasing function of velocity, and it can be used in place of the velocity as the independent variable.

A comparison of data from this investigation with data from previous investigations which used the same sand showed that even a small decrease in the amount of fine material in the bed can have a significant effect on the transport rate. Even relatively large changes in the standard deviation of the bed material have a small effect on the friction factor.

W. M. Keck Lab. Hydraul. and Water Resources, Calif. Inst. Tech., Pasadena, Calif.

Peterson, F., Jr. INTERCEPTING DRAINAGE WELLS IN ARTESIAN AQUIFER. J. Irrig. and Drain. Div., ASCE 87(IR 1): 7-14. Mar. 1961.

A formula for channel seepage to a leaky artesian aquifer and for the resulting piezometric surface is presented. A potential function accounting for excess irrigation and leaching water applied to agricultural lands is proposed. Using this function in combination with conventional well potential theory, a method for designing intercepting drainage wells for such an aquifer underlying irrigated lands is described.

Utah State U., Logan, Utah.

Oakes, C. K. HYDRAULIC COMPUTATIONS FROM LIMITED INFORMATION. J. Hydraul. Div., ASCE 87(HY 1): 85-94. Jan. 1961.

A shortage of data and information on a project area often makes it necessary to employ methods designed to make the most of what are available in climatological, hydrological, and physical data in studies and investigations for drainage and flood control and the design of hydraulic facilities.

Methods, together with sample results, recommended in certain types of hydrologic and hydraulics computations are described for use where lack of time and/or funds will not permit obtaining additional basic data and information. Methods are discussed for computing peak discharge rates and discharge hydrographs from watersheds; discharge rates over embankments; low flows or runoff from watersheds; and stage-discharge relationships. Some of the improbabilities in computed results by the methods discussed are mentioned and where feasible, at least two methods are recommended as a check on the reliability of these results.

La. Dept. Public Works, Baton Rouge, La.

## Snow Surveys

Itagaki, K. AN IMPROVED RADIO SNOW GAGE FOR PRACTICAL USE. J. Geophysical Res. 64: 375-383. 1959.

A new type of radio snow gage has been developed. Its main features are: (1) A Geiger-Müller counter is buried under the snow layer so that the effect of temperature on the counter can be neglected; (2) the information obtained by this snow gage is sent by Morse code; (3) the relation between the water equivalent of snow and the number of Morse code is made to be linear; and (4) the information of temperature and humidity are sent at the same time. The mechanism and the results obtained by this snow gage are described.

Hokkaido U., Sapporo, Japan.

Archer, C. HOW MUCH WATER NEXT YEAR? SNOW SURVEYING WITH RADIATION. West. Crops & Farm Mangt. 10 (3): 31-32. 1961.

There are 1,390 snow courses in the 17 Western States. Each winter and spring 1,003 men take periodical readings of snow depth, water content of the snow, and moisture content of the soil underneath.

The Corps of Engineers has developed the radio-isotope method of snow measurement and is conducting the pilot work at Hemlock Butte. The snow-gauging device works this way: The radio-isotope is in a container in the ground. It sends radiation to a counter on a tower above. As the snow deepens, less radiation comes to the counter. The counter changes the radiation to radio impulses which flash from the tower to the Corps headquarters in Walla Walla, Wash. The rate of these impulses indicates the moisture in the snow cover.

To furnish a standard to compare with the automatically transmitted information, the Soil Conservation Service set up a snow course near the station on Hemlock Butte. With the Forest Service cooperating, the Soil Conservation Service will make repeated measurements of the snow depth and of the snow and soil moisture content.

The checking of the nearby snow course will continue for 5 years. By this time, the information, should be reliable enough to decide which method is the most dependable.

The expense of the radio-isotope type of snow-gauging station is a prime factor in the possibility of its more extensive use. Once proved practical and improved, and produced in quantity, it stands a good chance of becoming a standard--and time and expense saving--method of measuring snow.

The radio-isotopy station cannot report the moisture content of the soil beneath. This part of the story can be gathered as usual by the snow survey teams at more readily accessible points. The radio-isotope can perform a valuable function by giving the needed information from the courses which now require many hours of surveyors' time at considerable risk.

SCS, USDA, Orofino, Idaho.



# WATER MANAGEMENT

## Irrigation

Robins, J. S., and Haise, H. R. DETERMINATION OF CONSUMPTIVE USE OF WATER BY IRRIGATED CROPS IN THE WESTERN UNITED STATES. Soil Sci. Soc. Amer. Proc. 25: 150-154. 1961.

Certain of the many procedures for indirect estimation of consumptive use are discussed including the Blaney-Criddle, Thornthwaite, and Penman methods as well as evaporimeters such as atmometers and evaporation pans. The applicability and limitations in use of these procedures are analyzed including type and quality of data available, microclimatic effects, and use of derived information. When used with due caution and proper understanding of limitations, any of the procedures can be used for certain purposes.

Problems involved in determining evapotranspiration or consumptive use by irrigated crops are discussed and their implications in use of data obtained for specific situations are analyzed. These include sampling precision, frequency and time of sampling, crop rooting depth, stage of growth, type of crop, moisture status effects, climatic effects including advected heat, and percolation losses beyond the sampling zone.

SWCRD, ARS, USDA, Fort Collins, Colo.

Bishop, A. A. RELATION OF INTAKE RATE TO LENGTH OF RUN IN SURFACE IRRIGATION. J. Irrig. and Drain. Div., ASCE 87(IR 1): 23-29. Mar. 1961.

The relationship between the intake rate of the soil and the length of run in surface irrigation with regard to the amount of water lost below the root zone through deep percolation is presented. A nomograph is included from which the percentage of loss by deep percolation can be estimated for soils having different intake characteristics.

Utah State U., Logan, Utah.

Finkel, H. J., and Nir, D. DETERMINING INFILTRATION RATES IN AN IRRIGATION BORDER. J. Geophysical Res. 65: 2125-2131. 1960.

The relationship between the flow of water in an irrigation border and the infiltration rate of the soil as a function of time has been treated by previous authors, primarily by an analytical approach. A simple graphical construction is proposed whereby the time-infiltration curve can be constructed from data gathered in an irrigation border test under a wide range of field conditions, provided that the depth of flow over the surface is accurately measured during the trial.

Technion Israel Inst. Tech., Haifa, Israel.

van Bavel, C. H. M. WATER DEFICITS AND IRRIGATION REQUIREMENTS IN THE SOUTHERN UNITED STATES. J. Geophysical Res. 64: 1597-1604. 1959.

The frequency of exhaustion of available moisture supplies and the attendant water deficits have been determined for 9 Southern States. The results are based upon estimated daily moisture balances computed for 25 years at 264 stations. Evapotranspiration was estimated with the Penman formula.

Results are given in terms of two parameters: storage capacity of the root zone and recurrence probability. The values obtained have immediate practical value for a number of agrohydrological and agronomical applications. Among these are the estimation of irrigation requirements for river basins, farms, and individual fields, as well as estimation of drought hazard.

Generalized, the results indicate typical occurrence of severe drought throughout the South during the growing season. It appears that soil-moisture storage capacity and recurrence frequency are more important than geographical location in determining water deficits.

SWCRD, ARS, USDA, Tempe, Ariz.

Gard, L. E., McKibben, G. E., and Jones, B. A., Jr. MOISTURE LOSS AND CORN YIELDS ON A SILT-PAN SOIL AS AFFECTED BY THREE LEVELS OF WATER SUPPLY. Soil Sci. Soc. Amer. Proc. 25: 154-157. 1961.

Soil moisture extraction patterns were obtained on a silt-pan soil during four corn production seasons at three levels of water supply. Water requirements under southern Illinois average temperature conditions were determined for corn at different stages of development. The water requirements were compared with the amount and pattern of rainfall for the previous 21 years in order to estimate irrigation needs for maximum corn yields.

A requirements in excess of 3 to 4 1/2 inches of soil-stored water resulted in reduced corn yields. The use of two 2-inch irrigations 10 to 14 days apart during the tasseling and shooting stages of growth resulted in economically desirable corn yield increases 3 out of 4 years. Irrigation other than the 4 inches during tasseling and shooting stage resulted in no yield increases or only slight increases.

Lack of easily available moisture apparently lowers the corn yield potential on this soil in over one-half of the years. Water stored below 2 feet was of very limited direct value to the corn crop. A high state of soil fertility was conducive to efficient water use.

Ill. Agr. Expt. Sta., Urbana, Ill.

Richards, S. J., and Marsh, A. W. IRRIGATION BASED ON SOIL SUCTION MEASUREMENT. Soil Sci. Soc. Amer. Proc. 25: 65-69. 1961.

Soil suction (soil moisture tension) from zero to 0.8 bar is explicitly indicated by tensiometers. Higher values can be measured by suitably calibrated soil moisture resistance units. An irrigation program, both as to timing and duration of applications, can be carried out based on day-to-day records of soil suction at two or more depths in the root zone of the crop involved.

Available moisture depletion is a commonly used basis for recommending irrigation practices. Curves are presented which show that, when irrigation timing is based on a given value of available moisture depletion, irrigations may be applied at widely differing values of soil suction if soil texture varies. A layered soil experiment shows the usefulness of soil suction measurements for evaluating relative moisture conditions in soils of varying texture.

Examples are given of irrigation practices by avocado growers, which are based on tensiometer readings. When related to soil suction measurements, an irrigation program is adapted to soil, climate, and plant variables.

The author concludes that soil suction is a physical property of film water in soil. Instruments for evaluating soil suction can provide a day-to-day record of water conditions in the root zone of crops. The timing and duration of applications of an irrigation program can be based on soil suction records. Pertinent

soil properties are intrinsically accounted for in such a program without measuring them, and the conventional soil water content variable is not needed or used.

U. Calif., Citrus Expt. Sta., Riverside, Calif.

Corey, G. L., and McFall, R. MEASUREMENT OF WATER OVER STILTED-IN WEIRS. Idaho Agr. Expt. Sta. Res. B. 47, 16 pp. 1960.

Weirs that have silted-in no longer operate as standard weirs. The velocity of approach becomes greater than  $1/2$  feet per second and is greater than standard conditions. The weir crest height above the channel bottom is reduced. For these reasons the usual method of measurement over them is inaccurate.

It is possible to utilize these weirs as accurate measuring devices, if the depth of flow is measured with a gage held on the weir crest. The value of the depth measured in this manner includes the true depth of flow and a certain amount of pile-up on the gage face caused by the approach-velocity.

The study related the depth of flow measured with a  $1/2$  inch square gage to the discharge over the weir. It was found that for the method of measurement used, the crest height above the channel floor has very little effect on the measurement and may be eliminated as a variable.

Equations were developed relating discharge to gage depth and tables that may be used to determine discharge are presented.

U. Idaho, Col. Agr., Moscow, Idaho.

Staff Writer. NEW TYPE WATER CONTROL DEVICE. Irrig. Engin. and Maintenance. 11 (5): 12. 1961.

Engineers at Utah State University have started extensive field tests on a new, all-steel irrigation water control device.

Field tests of the galvanized steel units, adaptable to any farm irrigation need, will continue in six key Western States.

The new irrigation structure, designed by Utah State University irrigation engineers, features three pre-formed components that can be easily assembled into a variety of sizes and shapes to form diversion structures for diverting stream flow from one ditch to another, check gates to dam up water so it will flow from the ditch onto the land, drop structures for preventing erosion when water drops rapidly from one elevation to another, and field turns-out for diverting part of the stream flow onto a field.

A major advantage of the new device is that it can serve either as a permanent structure or can easily be moved to another location. It also provides durability and low maintenance costs, as well as adjustable water control in any type of soil.

Irrig. Engin. and Maintenance, H. L. Peace Publications, 624 Gravier St., New Orleans 9, La.

Smerdon, E. T., and Hohn, C. M. RELATIONSHIPS BETWEEN THE RATE OF ADVANCE AND INTAKE RATE IN FURROW IRRIGATION. Tex. Agr. Expt. Sta. MP-509, 11 pp. 1961.

Research was conducted in 1960 at the A & M Plantation, College Station, Tex., and at the Soils and Crops Unit, Substation No. 9, Pecos, Tex., to determine relationships between infiltration rate of soils and the rate of advance of the wetting front in furrow irrigation. These research data were used to evaluate analytically determined relationships between infiltration and the rate of advance. The relationships presented are valid for all soil types.



A method is presented for determining the infiltration rate during furrow irrigation by taking measurements on a furrow being irrigated. The method is applicable directly to conditions where both the rate of advance of the wetting front in the furrow and the infiltration rate can be expressed as a simple power function. This method of representation is satisfactory for most observed data on furrow irrigation.

In a given field, the infiltration rate, as determined from rate of advance measurements on several different furrows, compares better than when it is determined by furrow infiltrometers. In soils which show a tendency to develop cracks upon drying, the furrow infiltrometer measurements proved erratic and difficult to correlate.

A method is given for estimating the rate of advance of the wetting front in irrigation furrows when the infiltration rate is known. This method will be applicable in the evaluation of irrigation systems to estimate the furrow stream size necessary for efficient application of irrigation water. It also will be useful in the preliminary evaluation and design of irrigation systems before land grading operations are performed.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Jensen, M. E. ed. PROCEEDINGS OF THE ARS-SCS WORKSHOP ON HYDRAULICS OF SURFACE IRRIGATION. DENVER, COLORADO, FEBRUARY 9-10, 1960. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-43, 110 pp. 1960.

The hydraulics of flow in surface irrigation systems is extremely complex; therefore, has essentially been neglected for many years. Irrigation engineers in the Soil Conservation Service have been requested to design increasing numbers of irrigation systems. Because of a lack of information on surface hydraulics, they have been forced to develop and use empirical relationships to design these systems.

A number of research projects have been initiated during the past 5 years using analytical approaches, laboratory flumes or models, and field studies to determine the relationships involved in the hydraulics of surface irrigation systems.

This workshop was held for the following reasons: (a) To bring to attention of research engineers the current empirical procedures being used by design engineers with emphasis on procedures that need improvement; (b) to acquaint the design engineers with research underway and to provide them with recent data or relationships that may be incorporated into present design procedures; (c) to provide an opportunity for design and research engineers to discuss mutual problems; and (d) to provide research engineers an opportunity to discuss their research projects.

A major portion of the current research being conducted in the United States on hydraulics of surface irrigation systems is represented in the following papers published in these proceedings:

Shockley, D. G. PRESENT PROCEDURES AND MAJOR PROBLEMS IN BORDER IRRIGATION DESIGN. SCS, USDA, Portland, Oreg.

Lawhon, L. F. ATTEMPTS AT IMPROVEMENT OF DESIGN PROCEDURES FOR BORDER IRRIGATION. SCS, USDA, Fort Worth, Tex.

Bassett, D. L., and Tinney, E. R. WATER SURFACE CONFIGURATION AND VELOCITY OF ADVANCE IN HYDRAULIC LABORATORY TESTS. Wash. Agr. Expt. Sta., Pullman, Wash.

Bondurant, J. A. HYDRAULICS OF SURFACE IRRIGATION. SWCRD, ARS, USDA, Boise, Idaho.

- Bowman, C. C. MANNINGS EQUATION OF SHALLOW FLOW. Mont., Agr. Expt. Sta., Bozeman, Mont.
- Hansen, V. E. MATHEMATICAL RELATIONSHIPS EXPRESSING THE HYDRAULICS OF SURFACE IRRIGATION. Utah State U., Logan, Utah.
- Davis, J. R. CONCEPTS ON DESIGN OF BORDER IRRIGATION SYSTEMS. U. Calif., Davis, Calif.
- Phelan, J. T. DESIGN PROCEDURES AND RESEARCH NEEDS FOR THE FURROW METHOD OF IRRIGATION. SCS, USDA, Lincoln, Nebr.
- Shull, H. FURROW HYDRAULICS STUDY AT THE SOUTHWESTERN IRRIGATION FIELD STATION. SWCRD, ARS, USDA, Brawley, Calif.
- Thornton, J. F. SUMMARY OF HYDRAULICS OF FURROW IRRIGATION STUDIES IN MISSOURI. SWCRD, ARS, USDA, Columbia, Mo.
- Davis, J. R. ESTIMATING RATE OF ADVANCE FOR IRRIGATION FURROWS. U. Calif., Davis, Calif.
- Kruse, E. G. HYDRAULICS OF SUBCRITICAL FLOW IN SMALL, ROUGH CHANNELS. SWCRD, ARS, USDA, Fort Collins, Colo.
- Swanson, N. P. HYDRAULIC CHARACTERISTICS OF SURFACE RUNOFF FROM STIMULATED RAINFALL ON IRRIGATED FURROWS. SWCRD, ARS, USDA, Lincoln, Nebr.
- Little, W. C. THE DESIGN OF FURROW IRRIGATION SYSTEMS. SWCRD, ARS, USDA, Watkinsville, Ga.
- ARS, USDA, Inform. Div., Washington 25, D. C.
- Pauls, D. E., and Parrish, B. D. COMPARISON OF SPRINKLER AND SURFACE IRRIGATION METHODS, 1956 AND 1957. Wash. Agr. Expt. Sta., Sta. C. 367, 6 pp. 1960.

The costs of sprinkler and surface irrigation in the Columbia Basin Project for 1956 and 1957 are compared.

Sprinkler-irrigated farms used less water per acre irrigated than did surface-irrigated farms. The degree of difference varied, which may be the result of weather conditions and the kind of crops grown.

The amounts of water used were compared with theoretical requirements of the crops. Sprinkled farms applied 134 percent and surface-irrigated farms 136 percent of these requirements in 1956. In 1957 these rates were 91.7 for surface and 114 percent for sprinkler systems.

Surface-irrigated farms reported higher average crop yields in 1956 and sprinkler-irrigated farms higher average crop yields in 1957.

An appreciable difference in fertilizer use between farmers using surface methods of irrigation and those using sprinkler systems was indicated. The reason for this difference is not apparent.

Irrigation costs per acre were higher on sprinkled farms for the 2 years reported. Costs considered were power requirements, floating, corrugating, interest on investment, repairs and replacement, maintenance, and water distribution labor.

Total costs per acre on sprinkler-irrigated farms were \$21.68 in 1956 and \$17.46 in 1957. The per acre costs on surface-irrigated farms were \$10.20 in 1956 and \$7.53 in 1957.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Pair, C. H. SPRINKLER IRRIGATION IN THE U.S.A. (1) World Crops. 13 (4): 127-130. 1960. (2) World Crops. 13(5): 186-189. 1960.

Most sprinkler systems in the U.S.A. are portable or semi-permanent types having hand-moved laterals. The mechanization of these hand-moved laterals began with the development of the powered side-roll, the pull-wheel, dragline, giant sprinkler, self-propelled, and solid systems. These mechanized systems will require a larger capital investment, but will reduce labor costs and so justify their higher cost.

Sprinkler irrigation in the U.S.A. started 60 years ago. It has grown until about 10 percent of the total irrigated acreage of almost 38 million acres is now sprinkler irrigated. It is increasing at the rate of 200,000 acres per year and it is expected that sprinkler irrigation will be used more and more in the future.

The various types of sprinkler systems are described and illustrated.

SWCRD, ARS, USDA, Boise, Idaho.

Koch, K. A. NITROGEN VAPORIZATION LOSS IN SPRINKLER IRRIGATION. Trans. ASAE 3(2): 22-23, 28. 1960.

The amount of nitrogen lost to the air in sprinkler irrigation is affected by a number of variables of which the concentration of nitrogen is perhaps the most important.

This study was limited to a water soluble 13-13-13 solid fertilizer, a 32 percent nitrogen solution, and anhydrous ammonia. The source of nitrogen of the solid fertilizer was a monoammonium phosphate and the liquid fertilizer was an ammonium nitrate-urea solution.

An analysis of the results indicate that the following conclusions can be drawn:

1. Varying the nitrogen concentration of the solution, the distance from the sprinkler, the pressure at the nozzle, and the temperature of the solution, or the pH of the solution caused no significant difference in the nitrogen concentration of the monoammonium phosphate solution or the ammonium nitrate-urea solution after they had traveled from the sprinkler nozzle to the catch table.
2. With the anhydrous ammonia solution the following results were obtained; (1) Percentage loss of ammonia were practically the same for concentrations of 400 to 1500 p.p.m. (approximately 30 percent). (2) Losses of ammonia increased as the pressure increased. Losses of ammonia decreased as the distance from the sprinkler increased. (3) The loss of ammonia was accelerated as the temperature of the solution increased. And (4) varying the pH of the ammonia solution from 7.8 to 10.7 increased the loss only from 27 to 30 percent.

La. State U., Baton Rouge, La.



Swarner, L. R. USBR PROJECT TYPE SPRINKLER SYSTEMS: I. Irrig. Engin. and Maintenance. 11(4): 13-15, 22-23. 1961.

Swarner, L. R. USBR PROJECT TYPE SPRINKLER SYSTEMS: II. Irrig. Engin. and Maintenance. 11(5): 15-18. 1961.

Part I describes the United States Bureau of Reclamations Project for Sprinkler systems by explaining the design of distributing systems, main discharge pipelines, regulating reservoirs, and pumping plant.

Part II describes pumping plant controls and the systems construction and operation.

Irrig. Engin., U. S. Bur. Reclam., Region I.

Lofgren, B. E. NEAR-SURFACE LAND SUBSIDENCE IN WESTERN SAN JOAQUIN VALLEY, CALIFORNIA. J. Geophysical Res. 65: 1053-1062. 1960.

Numerous evidences of land subsidence have been observed on unusual soils in the San Joaquin Valley immediately after the application of water. This subsidence results in extensive settling and cracking of soil along ditches, and in irregular, undulating topography in irrigated areas. Experiments on quarter-acre test plots were made to determine the nature and magnitude of near-surface subsidence on different types of alluvial deposits. After 27 months of observation, surface bench marks had settled an average of 10.50 feet; a bench mark anchored at a depth of 25 feet had settled 9.44 feet; a bench mark at 50 feet, 8.13 feet; a bench mark at 75 feet, 6.13 feet; a bench mark at 100 feet, 3.93 feet; and a bench mark at 150 feet, 0.39 foot.

Infiltration at a continuing rate of 0.20 foot of water per day for a 15-month period of inundation was more than sufficient to fill the pore space beneath the test plot to the wetted front, and considerable lateral spreading of the water occurred. Core samples collected before and during the spreading operation show the increase in density and moisture content of the subsurface deposits. The low field density and extreme dryness of the alluvial deposits apparently are two important factors in land subsidence due to application of water.

U. S. Geol. Survey, Sacramento, Calif.

Davis, S., and Schumaker, G. A. IRRIGATION PRACTICES FOR INCREASING CROP PRODUCTION AND MOSQUITO CONTROL. Trans. ASAE 4(1): 21-23. 1961.

Irrigation-caused mosquito problems tend to be acute in areas having plentiful water supplies, little slope, and low-intake-rate soils devoted to the production of low income crops such as native hay. All of these conditions exist in the Milk River Valley of Montana. Cooperative studies were conducted in this valley by the U.S. Public Health Service and the Montana Agricultural Experiment Station to develop procedures that would improve these undesirable conditions.

It was concluded that use of suggested crops, nitrogen fertilizer, and frequent, light irrigations will help increase per-acre income and reduce mosquitoes.

SWCRD, ARS, USDA, Grand Junction, Colo.

The data from a 20-year lysimeter investigation with an irrigated soil (Holland 1) were presented and discussed. The following paragraphs summarize the results.

Yields of Crops. Applications of N to winter annual legumes produced small but consistent increases in yields. There were large increases in yields of winter-grown mustard as a result of N applications. The summer crop, which was barley for the first 6 years and the Sudangrass the rest of the time, gave no increase yield from N where a winter legume was grown and turned under and relatively small increases where mustard was grown as a winter crop or where straw was added in the winter.

The growth of vetch and melilotus winter legumes were as effective as mustard as a winter crop plus 135 pounds N per acre in supplying the summer crop with N.

Nitrogen. Nitrogen fixation by the winter legumes was 131, 106, and 77 pounds per acre per year for vetch treated with 0, 100, and 200 pounds N per acre per year, respectively. Comparable data for melilotus were 124, 82, and 67 pounds N per acre per year, respectively. There were no significant gains or losses of N in the tanks treated with straw or the growth of mustard in combination with N applications.

Phosphorus. The average depletion of P from the soil was 15.9 pounds P per acre per year.

Potassium. The average depletion of K was 181 pounds K per acre per year.

Magnesium. There was a small average loss of Mg from the soil. However within each winter crop or crop residue treatment there was a decrease in Mg accumulation or an increase in Mg loss with increase in the rate of application of N as  $\text{Ca}(\text{NO}_3)_2$ .

Sodium. The average Na accumulation was 116 pounds per acre per year, which was 69 percent of the Na added.

Chloride. The average accumulation of Cl was 3 pounds per acre per year or about 2 percent of that added. About 81 percent of the added Cl was removed by the summer crop and about 17 percent was removed by leaching.

Sulfur. The average S accumulation was 16.8 pounds per acre per year which was 48 percent of that added.

Calcium. The average Ca accumulation was 62 percent of that added. Eighty-six percent of the Ca accumulated was precipitated as  $\text{CaCO}_3$  in the soil and 14 percent was used in neutralizing soil acidity. The  $\text{CaCO}_3$  precipitated in the soil was significantly related to leaching percentage, type of crop, and to total Ca added. The Ca added as  $\text{Ca}(\text{NO}_3)_2$  had a soil amendment effect in reducing the exchangeable Na.

Drainage Water. Because of crop removal of Cl and precipitation of  $\text{HCO}_3$  as  $\text{CaCO}_3$ , the drainage water in the 1951-52 season was mainly a solution of  $\text{SO}_4$  salts. Sodium and  $\text{SO}_4$  showed the greatest concentration relative to the composition of the irrigation water.

Exchangeable Cations in the Soil. The exchangeable K decreased with increase in depth. Applications of Ca as  $\text{Ca}(\text{NO}_3)_2$  displaced Mg from the surface layers (0 to 24 inches) and prevented accumulation of Na in the soil of the same depth. Exchangeable Na accumulated in the 24- to 48-inch depth and where  $\text{Ca}(\text{NO}_3)_2$  was added exchangeable Mg accumulated in the same depths.

Total Nitrogen and Organic Carbon. Losses of N and organic C were greatest at the lowest depths. The surface soil increased in both N and organic C during



the 20 years of cropping, but there were no changes during the 7 years of fallow that preceded the cropping period. During the fallow period the lower depths lost organic C.

Agr. Publications, 207 U. Hall, 2200 U. Ave., Berkeley 4, Calif.

Scarsbrook, C. E., Bennett, O. L., Chapman, L. J., Pearson, R. W., and Sturkie, D. G. MANAGEMENT OF IRRIGATED COTTON: RESULTS OF COTTON IRRIGATION MANAGEMENT STUDIES IN ALABAMA. Ala. Agr. Expt. Sta. B. 332, 23 pp. 1961.

The results of irrigation experiments during the past 5 years to determine effect of nitrogen, moisture, varieties, topping, spacing, date of planting, and bottom defoliation on yield, fiber properties, and other characteristics of cotton are presented. The experimental work was summarized as follows:

1. Yields in excess of 5,000 pounds of seed cotton per acre were produced in the State when adequate moisture and fertilization were combined with other good management practices.
2. Cotton has shown yield responses to nitrogen rates as high as 360 pounds of N per acre. With present varieties and insect control, about 120 pounds of N is a more practical rate for irrigated cotton.
3. To obtain yield responses from high rates of nitrogen or high rates of moisture, both must be used with other good management practices.
4. Topping cotton to a height of 42 to 48 inches controlled lodging and did not reduce yields.
5. Defoliation of the lower 2 feet of plants with magnesium chlorate when three-fourths of the bolls were of mature size reduced the 3-year average yield by 491 pounds of seed cotton per acre.
6. Planting 1 month later than the recommended date reduced the 3-year average yield by 752 pounds of seed cotton per acre.
7. Cotton with plant populations of 30,000 and 10,000 lodged less than populations of 5,000 plants per acre.
8. With high rates of nitrogen and moisture, serious lodging problems were often encountered.
9. There were marked differences in lodging among cotton varieties when grown with high rates of nitrogen and moisture. Some varieties lodged almost completely, whereas others practically none when 300 pounds of N per acre was applied.
10. No lodging was observed with any of the varieties tested when all fruit was removed from the plants.
11. The severity of boll rot was dependent upon the kind of season as well as the amount of rank growth and lodging.
12. Even with the same nitrogen and moisture rates, some varieties differ a foot or more in plant height from season to season.
13. Nitrogen decreased the lint percentage, but increased boll weights and seed weights, and had no effect on micronaire values.
14. Irrigation increased the fiber length and had a variable effect on micronaire depending on the season.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

Hohn, C. M., Fisher, F. L., and Caldwell, A. G. MOISTURE-FERTILITY RELATIONS OF COTTON AT COLLEGE STATION, 1957-59. Tex. Agr. Expt. Sta. MP-470, 6 pp. 1960.

Cotton grown on Norwood silt in the Brazos River Valley near College Station, Tex., indicated a favorable response to both nitrogen and irrigation when a proper balance between these factors was maintained. Production ranged from

a low of 480 to a high of 1,090 pounds of lint per acre. Excessive nitrogen in 1958, combined with the large amount of late season rain, produced the lowest amount of lint, while 160 pounds of nitrogen under the high-moisture treatment produced 1,090 pounds of lint in 1959. Maximum production in 1959 increased from 990 to 1,090 pounds when the moisture level was increased from the lowest level to the highest. These tests show that the minimum level of irrigation gave satisfactory results with the proper fertility balance. The low-moisture level, 15 percent available moisture (A.M.), produced as much or more lint as the medium level, 35 percent A.M., under all fertility ranges.

Based on these results, 80 pounds of nitrogen applied at or before planting is recommended. Using a small amount of phosphoric acid (20 to 40 pounds per acre) with or near the seed acts as a balancing medium for earlier maturity of the cotton. Early planted cotton could respond to an application of an additional 40 to 80 pounds of nitrogen as a sidedressing. This sidedressing should not be applied after May 15. The final water should be applied about August 1 and not later than August 15, since late irrigation tends to delay maturity, thereby increasing the hazard of damaged lint by early fall rains.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Nunnery, S. A., and Wilson, T. V. SEVEN YEARS OF COTTON IRRIGATION EXPERIMENTS. S. C. Agr. Expt. Sta. B. 485, 10 pp. 1960.

Irrigation is gradually becoming a part of cotton production in humid regions where rainfall is usually adequate but distribution is seldom ideal for good plant growth.

Cotton irrigation experiments over a 7-year period indicate that seed cotton yields can be increased by applying water at the right time. The expected increase will vary from year to year depending upon the rainfall distribution. The most effective and profitable use of water was obtained by irrigating when the cotton wilted by 10 a.m.

Normally about 20 to 25 inches of rainfall are expected during a growing season, and if distribution is good there is enough water for a bumper crop.

Irrigation not only affects the yield, it affects the quality of the cotton fiber as well. Limited data as shown by upper half mean lengths of the various treatments indicate staple lengths can be increased 1/16 to 3/32 of an inch by irrigation.

Table.--Profit from Cotton Irrigation Based on Tests at Clemson, South Carolina, 1953-1959.

Year	No. of irrigations	Approx. cost of irrigating	Yield increase lb/ac		Gross ret. from irrigation (Per Ac.)	Net profit from irrigation (Per Ac.)
			Seed cotton	Lint cotton		
1953.....	2	\$30.00	655	249	\$ 82.00	\$52.00
1954.....	3	\$40.00	797	303	\$100.00	\$60.00
1955.....	1	\$25.00	357	136	\$ 45.00	\$20.00
1956.....	4	\$40.00	408	155	\$ 51.00	\$11.00
1957.....	3	\$35.00	726	276	\$ 91.00	\$56.00
1958.....	0	\$20.00	0	0		-\$20.00
1959.....	1	\$25.00	351	133	\$ 44.00	\$19.00
Avg. ....	2	\$30.70	470	179	\$ 59.00	\$28.30

It is important to harvest cotton as early as possible to maintain the high quality fibers attained by irrigation.

Irrigation as it is known today is not a cure-all for the problems associated with hot, dry weather, and will never replace the climatic conditions associated with good rainfall distribution. The rainfall distribution in South Carolina is such that a plant's water requirements are seldom fulfilled throughout the entire growing season; therefore, irrigating is becoming a necessity in order for cotton producers to obtain all of the potential profit in cotton production.

S. C. Agr. Expt. Sta., Clemson Col., Clemson, S. C.

Longenecker, D. E., Thaxton, E. L., Jr., and Lyerly, P. J. YIELD, EARLINESS AND LINT PERCENT OF IRRIGATED UPLAND COTTON AS AFFECTED BY NITROGEN, PHOSPHATE AND AMOUNT OF WATER APPLIED, PECOS, 1959-60. Tex. Agr. Expt. Sta. Prog. Rpt. 2176, 8 pp. 1961.

Results of fertility-irrigation tests for 2 years at Pecos, Tex., are reported. Yield, earliness, and lint percent of 1517C cotton were affected by both fertility level, and rate of water application.

Frequent summer irrigation (every 7 days) had an adverse effect on yield, percent first picking, and lint percent. Excessive water reduced seed cotton yields about 500 lbs. per acre, delayed maturity appreciably, and reduced lint turnout 1 to 1-1/2 percent. Less frequent irrigation (every 14 days) produced shorter, thriftier plants with a heavier boll load.

With less water, the cotton made more efficient use of applied nitrogen. Maximum increase over the no-nitrogen plots was about 800 lbs. of seed cotton with 14-day irrigation, as compared with about 500 lbs. with 7-day irrigation.

Application of superphosphate had little or no effect on yield, earliness, or lint percent.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Matlock, R. S., Garton, J. E., and Stone, J. F. PEANUT IRRIGATION STUDIES IN OKLAHOMA, 1956-1959. Okla. Agr. Expt. Sta. B. B-580, 19 pp. 1961.

Irrigation of peanuts resulted in improved yields during the 4-year period, 1956-59. Three levels of water were used--low, medium, and high. The highest yield increases over nonirrigated peanuts were obtained with the medium and high-water levels. Though the maximum yield potential was not realized, the yields for each year gave an indication of the relative merit of the treatment.

The data indicate that if the water supply is limited, two to three irrigations of about 3 inches each will produce the highest returns per acre per inch of water. Under these conditions, maximum returns per acre per inch of water added ranged from \$10.50 in 1958 to \$26.10 in 1959. The data also indicate that if the water supply is not limited, a higher irrigation level, i. e., 3 to 6 irrigations, depending upon rainfall, would give a greater return. The maximum returns per acre under these conditions ranged from about \$202 to \$384.

The mean percentages of sound mature kernels increased for the low and medium irrigation treatments over that of the no water treatment. For the period 1956-58, the mean percentages of sound mature kernels in the high-water treatment was higher than that of the no-water treatment but less than the medium and low-water levels. Except in years of severe drought stress, there was an increase in the number of peanuts produced but a general decrease in the size of the kernels as irrigation levels were increased. Considering all four years and all water treatments, the variance of the peanut size distribution curves were practically identical. The only deviation from this was observed in



the 1956 season. The grouping of peanut seed sizes about the mean size appeared to be independent of the season or the moisture treatment.

The foreign material tended to increase with irrigation as a result of more soil clinging to the pods of the peanuts produced under irrigation.

The data for the 4-year period 1956-59 indicated a slight decrease in protein content in 1957, 1958, and 1959 as the irrigation level was increased. The pattern was not followed in 1956 probably because of the effect of severe drought stress on chemical composition. There was little effect on mean oil percentages among the various treatments in 1957, 1958, and 1959, while oil content in 1956 decreased slightly as water level increased. The mean oil content ranged from 51.0 to 54.4 percent in 1957 and from 43.2 to 46.7 percent in 1956, while the oil contents of the peanut seed in 1958 and 1959 were intermediate.

Taste panel results indicated that the flavor and odor of peanut butter was improved by irrigation in droughty seasons and that the quality was not impaired when peanuts were irrigated at a moderate rate in the more normal seasons.

Pod measurements indicated that there was a decrease in the length, diameter, thickness, and pressure required for cracking peanut pods as the water level was increased. The measurements were made on peanut samples that were not separated according to maturity.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Gabelman, W. H., and Williams, D. D. F. DEVELOPMENTAL STUDIES WITH IRRIGATED SNAP BEANS. Wisc. Agr. Expt. Sta. Res. B. 221, 56 pp. 1960.

The results of experiments with snap beans carried out from 1953-59 on Plainfields are summarized. These experiments were initiated to: (1) Establish the potential of irrigated beans in the Central Sand Area of Wisconsin; and (2) study the effect of irrigation and fertilizer practices on flowering, fruit setting, and pod development, thereby analyzing the components of yield.

The advent in 1953 of a commercially acceptable mechanical bean harvester ushered in a new era in the production of beans for the canning industry. It generated several problems which this industry had not encountered, and concerning which little or no research information was available. Studies pertinent to these problems were incorporated into the original program as it progressed.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

Veihmeyer, F. J., and Hendrickson, A. H. RESPONSES OF A PLANT TO SOIL-MOISTURE CHANGES AS SHOWN BY GUAYULE. Hilgardia 30(20): 621-637. 1961.

From 1943 to 1946, field and tank studies on responses of guayule to different soil-moisture conditions were conducted at Davis, Calif.

Three types of treatment were begun in the spring of the second season: (1) Irrigation when the soil moisture in the top 3 feet was reduced to about 14 percent; (2) irrigation when the soil moisture was reduced to about the permanent wilting percentage (PWP); and (3) no irrigation.

Results from the final sampling of the field plots when the crop was harvested showed clearly that the irrigated treatments produced larger plants than the nonirrigated plots, which were allowed to remain at the PWP for a long period. In rubber content, the lowest percentage was found in the treatment where the soil moisture was kept relatively high. The treatment in which the soil moisture was reduced to a much lower level several times during the season produced slightly, but not significantly, larger plants and a significantly higher percentage of rubber than did the treatment in which a relatively high-moisture content was maintained. All treatments increased markedly in percentage of rubber during the winter. The nonirrigated treatment produced the highest rubber content of all.

Results in the tank tests were in agreement with those in the field. The largest plants were produced in the tanks in which the soil moisture was allowed to be reduced to about the PWP, but not to remain there for an appreciable time. Maintenance of the moisture above a high level by frequent irrigations did not increase the growth of plants over those in the drier soil.

The data indicate that soil moisture between the field capacity and the PWP is readily available to guayule plants.

Agr. Publications, 207 U. Hall., 2200 U. Ave., Berkeley 4, Calif.

Nelson, C. E., and Roberts, S. PROSO GRAIN MILLET AS A "CATCH CROP" OR "SECOND CROP" UNDER IRRIGATION. Wash. Agr. Expt. Sta., Sta. C. 376, 5 pp. 1960.

Grain millet (Panicum milaceum), also known as proso or hog millet, was investigated as a possible "catch crop" or "second crop" for irrigated central Washington.

Proso is different from other millets (Setaria species). Proso millet is not palatable to livestock as a pasture or hay crop. The grain can be used for birds, poultry, and livestock.

The effects of three nitrogen levels and four rates of seeding on three varieties of proso grain millet were studied at three seeding dates.

The average grain yields for the seeding dates were: June 17, 2,881 lbs.; July 7, 2,991 lbs.; and July 22, 1,618 lbs. per acre.

Canadian Crown produced the highest grain yield, followed by Early Fortune, and Improved White Proso.

For all three seeding dates, 30 lbs. of seed per acre is adequate for maximum grain yields. The 50-lb. per acre seeding rate decreased grain yields.

Important facts to consider in deciding to grow this crop are: (1) Alfalfa, pasture, barley, oats, wheat, corn, and late potatoes should follow proso millet in the rotation with normal cultural practices. The volunteer millet may become a weed problem for one season with certain crops unless special practices are used. (2) The time of seeding is from about June 15 to July 7, as it is strictly a warm season crop. (3) The plants always lodge. (4) The crop must be mowed and swathed before combining. (5) The windrows must be turned to facilitate drying--and fall rains may be expected to interfere with harvesting. And (6) the grain does not sprout or spoil when wet in the windrow.

This is a culture and care circular on growing and storing of proso grain millet.

Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Schumaker, G., and Davis, S. NITROGEN APPLICATION AND IRRIGATION FREQUENCIES FOR WESTERN WHEATGRASS PRODUCTION ON CLAY SOIL. Agron. J. 53: 168-170. 1961.

A nitrogen rate-moisture level study was conducted on a native western wheatgrass meadow in the Milk River Valley of northern Montana over a 4-year period. When the amount of water applied was reduced below 45 inches, or that generally used in spring flooding in the valley, a slight decrease in yield resulted if no nitrogen was applied. However, yields were increased when nitrogen was applied under the same moisture regime. Maximum yields resulted with the combination of frequent applications of irrigation water and high rates of N fertilization. Improved water management and N applications resulted in hay yields considerably higher than under the flood management common in the valley. Yields were maintained at a high level over the 4-year period with yearly applications of N. Nitrogen applications of 100 and 200 pounds per acre were most economical. Increased N rate increased the N content of the hay on all moisture

levels. A response to residual N was noted. The applied N recovered was extremely low, with highest recovery being 35 percent. With the exception of the spring-flood moisture treatment, no response to phosphate application was observed.

SWCRD, ARS, USDA, Grand Junction, Colo.

Dotzenko, A. D. EFFECT OF DIFFERENT NITROGEN LEVELS ON THE YIELD, TOTAL NITROGEN CONTENT, AND NITROGEN RECOVERY OF SIX GRASSES GROWN UNDER IRRIGATION. Agron. J. 53: 131-133. 1961.

Six grass species were evaluated for forage yield, total nitrogen content, and percentage nitrogen recovery under five levels of nitrogen fertilization.

Highly significant increases in forage yields were obtained from nitrogen application. Intermediate wheatgrass produced the highest yields under the high nitrogen rates, followed in order of decreasing yields by tall wheatgrass, tall fescue, tall oatgrass, smooth brome, and orchardgrass.

Nitrogen applications increased the total nitrogen content of the forage. In general, smooth brome had the highest nitrogen content followed in order of decreasing percentages by orchardgrass, intermediate wheatgrass, tall wheatgrass, tall fescue, and tall oatgrass.

High rates of nitrogen fertilizer resulted in loss of stand, as well as reduced percentage nitrogen fertilizer recovered in the forage.

Colo. Agr. Expt. Sta., Fort Collins, Colo.

Lorenz, R. J., Carlson, C. W., Rogler, G. A., and Holmen, H. BROMEGRASS AND BROMEGRASS-ALFALFA YIELDS AS INFLUENCED BY MOISTURE LEVEL, FERTILIZER RATES, AND HARVEST FREQUENCY. Agron. J. 53: 49-52. 1961.

Yields of brome and a brome-alfalfa mixture were obtained over a 3-year period from a factorial experiment involving 2 harvest frequencies, 3 levels of soil moisture, and various N and P rates.

Yields of brome were doubled by the application of 40 pounds and tripled by the application of 80 pounds of N at the low (nonirrigated) moisture level. Two-hundred pounds of N increased yields fourfold at the irrigated (medium and high) moisture levels.

No response to P was measured in Brome yields.

Yields at the medium- and high-moisture levels were very similar, both being significantly higher than the low-moisture level.

At the low-moisture level, yields of the mixture were equivalent to those of brome receiving 40 pounds of N, but when irrigated they were equivalent to those of brome receiving 120 and 160 pounds of N for the pasture and hay treatments, respectively.

The percentage of alfalfa in the mixture increased with time at the medium- and high-moisture levels, but decreased at the low-moisture level.

Frequent clipping reduced the average total yield of all treatments by 18, 33, and 29 percent at the low-, medium-, and high-moisture levels, respectively. Frequent clipping also held the percentage of alfalfa in the mixture at a lower level than cutting at hay stage. Irrigated hay plots contained 95 percent alfalfa after 3 years, whereas the frequently clipped pasture plots contained less than 80 percent alfalfa.

CRD, and SWCRD, ARS, USDA, Mandan, N. Dak.



Grass and legume species were seeded in simple grass-legume mixtures for evaluation as irrigated pasture at two locations in Montana. At Huntley, Mont., alfalfa, birdsfoot trefoil, and Ladino clover were each seeded with each of two strains of timothy and two strains of Kentucky bluegrass. At Creston, Mont., birdsfoot trefoil and Ladino clover were each seeded with orchardgrass, Alta fescue, smooth brome grass, intermediate wheatgrass, and Troy bluegrass. Mixtures in both studies were cut three to five times a year to simulate grazing. Yields were taken from 1949-51 at Huntley and from 1954-57 at Creston.

At Huntley, alfalfa-grass and birdsfoot trefoil-grass mixtures were higher yielding than Ladino clover-grass mixtures in each of 3 initial years of the test. Birdsfoot trefoil mixtures were lower yielding than alfalfa mixtures in the first 2 years, but were equal in yield in the third year. The low yields of Ladino clover mixtures were attributed to the depletion of the stand of clover because of inadequate irrigation and winter injury. Eleven years after seeding, all mixtures contained from 10 to 20 percent birdsfoot trefoil by weight. The original alfalfa-grass mixtures still contained 8 percent alfalfa. The original Ladino-grass mixtures were essentially devoid of Ladino clover. Yields of mixtures in 1959 were not influenced by the original legume, probably because all mixtures were essentially birdsfoot trefoil-grass mixtures at this time.

At Creston, birdsfoot trefoil-grass mixtures were lower yielding than Ladino clover-grass mixtures in the first 2 yield years, but were higher yielding in the last 2 years. Total yields for the 4-year period were not different for the mixtures involving these two legumes. Presumably birdsfoot trefoil would have shown a yield advantage had the experiment been continued beyond the 4-year test period. Both experiments show that birdsfoot trefoil does not decline in productivity with increasing age of stand as rapidly as does alfalfa or Ladino clover.

Timothy and bluegrass species or strains within each species did not differ in their contribution to the yield of mixtures during the first 3 years at Huntley. However, 11 years after seeding, bluegrass mixtures yielded more than did the timothy mixtures. Within each species, commercial bluegrass mixtures yielded more than did those containing Troy bluegrass and commercial timothy mixtures yielded more than did those containing Hopkins timothy.

The yield contribution of grass species differed markedly at Creston. Orchardgrass and Alta fescue mixtures were equal in yield and both yielded more than did mixtures containing smooth brome grass, intermediate wheatgrass, and Troy bluegrass for the 4-year period. As the latter three species were all sod-formers, it would appear that the lower yields may be attributed to sod-binding. The yield advantage of bunch-type grasses over sod-forming grasses has not been as apparent elsewhere in Montana. In trials at Bozeman, smooth brome grass contributed more to the yield of mixtures than did Alta fescue or orchardgrass and the yield contribution of bluegrass was equal to that of Alta fescue and orchardgrass. At Huntley, the sod-forming bluegrass was producing more than timothy, a bunch grass, in the eleventh year of production.

In both the Huntley and Creston experiments, the contribution of a grass or legume species to the yield of a mixture appeared to be independent of the associated species. It was concluded that for highest yields, one should use the most productive grass and legume for the area in a mixture.

Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Kneebone, W. R., and Greve, R. W. ECONOMIC POTENTIALS FROM BLUE GRAMA SEED PRODUCTION UNDER IRRIGATION IN NORTHWEST OKLAHOMA. J. Range Mangt. 14: 138-143. 1961.

Blue grama seed production under irrigation could be highly profitable to a diversified crop and livestock operation in northwest Oklahoma. Efficient use of the forage produced would tend to pay most of the production costs, leaving the seed as a cash crop. Since irrigation farmers in the area have been shifting from cash grain crops to marketing of irrigated produce through livestock, this crop would fit in particularly well.

Even though use of dieldrin insecticide would mean added production costs and impose some limitations on use of forage remaining after seed harvest, increased seed sets obtained would give appreciable extra net returns per acre when seed is sold on a quality basis.

Estimated net returns per acre to land, labor, management, and capital from seed and forage over the 6-year period ranged from a net loss of \$1 to a profit of \$131. Average net return was \$76.

Where all recommendations except insect control were followed, the range was from \$1 to \$110 profit with an average return of \$62.

U. S. South. Great Plains Field Sta., Woodward, Okla.

Stevens, D. M. SPRINKLER AND GRAVITY IRRIGATION:--INVESTMENT AND WATER REQUIREMENTS, OPERATING COSTS, AND LABOR INPUTS. Wyo. Agr. Expt. Sta. B. 378, 32 pp. 1961.

Sprinkler and surface irrigation was compared with regard to physical characteristics, investment costs, operating costs, labor requirements, and water requirements. The study was conducted in 1957 and 1958 by the farm-survey method. Time-and-motion studies were used, along with the survey method, when determining labor requirements.

Complete survey records were obtained from 23 farms in the Pine Bluffs area and 18 in the Torrington area. These two areas were similar as to climate, elevation, soil, precipitation, and crops. The major difference was the source of irrigation water.

Deep-well turbine-type pumps were used to lift the water from wells; in some cases centrifugal booster pumps were used to apply additional pressure for sprinkler lines. The most common size of pump measured 6 in. in diameter and pumped an average of 480 gal. per minute. Wells had an average depth of 105 ft. and pumped against an average lift of 52 ft. Electric motors were the main source of power.

Sprinkler systems of the rotating-sprinkler-head type were usually fully portable.

When planning a surface-distribution system, the farmer and the engineer must consider topography, water-holding capacity of the soil, infiltration rate of soil, kind and value of crops grown, and the surface-irrigation method employed.

When surface irrigating from wells, the average irrigated farm was 175 acres, each pumping unit serving about 80 acres. Electric motors were the main source of power, and the common size of pump was 8 in. Only 23 acres per pumping unit were leveled at a cost of \$32.43 per acre. The average depth of wells was 107 ft., with a pumping lift of 57 ft. There was an average of about 366 ft. of lined ditches per pumping unit.

When surface irrigating from canals, the average size of farm was 193 acres. Land leveling, the largest item of investment cost, represented 48 percent of the total. Ditch lining, mainly of concrete, represented over 10 percent of the total. Canals were the main source of water, although there was a small investment in motors and pumps to augment canal supplies by pumping from drain ditches.



From this study the following conclusions were drawn:

1. The original investment per pumping unit was \$5,816 for sprinkler systems, \$3,757 for surface irrigation from wells, and \$5,126 for surface irrigation from canals.
2. The original investment per acre was \$66.73 for sprinkler systems, \$46.85 for surface irrigation from wells, and \$26.52 for surface irrigation from canals.
3. The average irrigation cost per acre was \$16.54 for sprinklers, \$13.43 for surface irrigation from wells, and \$9.51 for surface irrigation from canals.
4. Acre-inches of water used per acre for a normal year were 14.1 for sprinklers, 20.7 for surface irrigation from wells, and 22.0 for surface irrigation from canals.
5. The cost per acre-inch was \$1.18 for the sprinkler method, \$0.65 for surface irrigation from wells, and \$0.43 for surface irrigation from canals.
6. Factors affecting the cost per acre-inch of sprinkler irrigation from wells were (1) size of unit, (2) total lift, (3) acre-inches per acre, and (4) investment per acre. These same variables were important in influencing costs per acre-inch when irrigating from wells by surface methods. For surface irrigation from canals, the irrigators with lowest costs per acre-inch had the largest farms and used the most water. They had the lowest investment costs per acre and the lowest labor cost per acre.
7. The cost per acre, including labor charge, for irrigating various crops from wells by sprinkler methods and surface methods, respectively, follows: potatoes \$24.18 and \$18.81, sugarbeets \$22.11 and \$18.98, alfalfa hay \$21.93 and \$15.91, pasture \$19.37 and \$12.59, corn \$18.05 and \$12.05, dry beans \$13.08 and \$12.78, and small grains \$8.54 and \$6.55.
8. The advantages of both sprinkler irrigation and surface methods of applying water are given.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

Kenedy, L. W. TOWARD A MORE EFFICIENT SPRINKLER SYSTEM. Irrig. Engin. and Maintenance 11(1): 10-11. 1961.

An inefficient and cumbersome irrigation system on the Verne Barbre farm southeast of Quincy, Wash., was costly to maintain, caused erosion, and gave low yields.

The problems with the existing system were two separate locations for sprinkler sumps, getting the water to these locations, and disposing of the overflow. A joint plan was developed with Barbre, a sprinkler dealer, and the Soil Conservation Service.

The plan provided for removal of a lateral canal abandoned when Barbre started sprinkler irrigation, installation of a buried steel main line on the site of the abandoned canal, construction of a single large reservoir capable of serving 211 acres in three farm units, and construction of a combination emergency overflow and inlet. The site for the reservoir was on ground, which would have been difficult to sprinkle due to its location in the curve of the main supply canal.

The cost of reorganizing the irrigation system was \$5,035.

When filled, the reservoir is 7 feet deep and holds approximately 1.5 acre-feet of water. The reservoir is 350 feet long and 72 feet wide. Approximately 2,500 yards of excavation were required.

Other benefits being realized from the reservoir and system is a reduction of ditch bank area, which contributes to the weed problem, and the weed screen that keeps the weed seeds out of the irrigation system. During the summer, the reservoir can be used for supervised swimming. The reservoir is an excellent source of water for fighting fires when needed.

"Formerly, I used as much water on 40 acres of surface irrigated land as I now use on 137 acres of land under sprinkler," Barbre says.

SCS, USDA, Quincy, Wash.

Cochran, R. A. FIGURING TOTAL SPRINKLER IRRIGATION COSTS. Irrig. Engin. and Maintenance. 11(2): 12-13. 1961.

Irrigation systems are installed in order to make a profit for the owner. It is necessary to be able to determine all of the costs of an irrigation system. This total cost can be compared with the benefits received, or the increase in income to determine what profit, if any, has been realized from the system.

Often the only cost considered is the initial cost of the system. This initial cost can be very misleading; in fact, the initial cost is often less than one-third of the total cost of irrigation.

A guide is presented that helps in figuring all of the costs of an irrigation system. Four examples of different systems in the same 40-acre field are presented on a chart.

Numerous tables.

National Rain Bird Sales and Engin. Corp., Azusa, Calif.

Oxley, R. IT PAYS TO GO 'ROUND IN CIRCLES. Irrig. Engin. and Maintenance. 11(2): 11, 25. 1961.

Two wells were drilled 200 feet deep to supply irrigation water for the farm. Water is pumped from 50 feet at 2,200 and 2,400 gallons a minute. An extensive irrigation system and seven self-propelled rotary sprinklers were installed. Each sprinkler line was permanently installed to irrigate a 40-acre field.

Water from either well can be pumped to any sprinkler line or either of two reservoirs. When the reservoirs are full, water from them can be used to operate the sprinklers. The reservoirs are dirt-fill ponds 180 feet square and about 5 feet deep, each holding approximately 3.75 acre-feet of water.

The sprinklers are mounted on 6-inch steel tubing elevated by steel towers to clear the crop. The towers move in line rotating around a pivot point or swivel, which also serves to feed the tubing. The sprinkler lines are 640 feet long. Sprinkler nozzles of varying sizes are spaced every 30 feet for an even distribution of water along the entire line. The towers are propelled along by water pressure in a hydraulic system. Each tower regulates its own speed to keep the line straight. If something should break down, the unit automatically shuts off. The water pressure in the line varies from 60 p.s.i. at the swivel to 50 p.s.i. at the end sprinkler.

From the wells to the reservoirs to the sprinkler lines there are steel pipe supply lines (6 to 10 inches in diameter), which are buried beneath the surface.

Rows of Russian olive trees have been planted around each 40-acre field for windbreaks. The shelter given by these trees provides enough protection so that the sprinklers can be operated even on fairly windy days.

"One man is able to irrigate the entire ranch without even turning a shovel," says Billingsley. "The savings in labor costs are terrific."

It costs approximately \$14 an acre per year for operating expense. This figure doesn't include depreciation of equipment. The cost of each sprinkler runs approximately \$7,000.

No address given.

A survey was made in the Lower Yellowstone Irrigation project to determine farmers' practices and experiences with irrigation farming. Information from this survey and other data were used to determine how investment in irrigation will compete with other uses of capital on dryland farms which may be using irrigation as a production tool.

Sixty-four farmers in the Lower Yellowstone area were interviewed to determine their current farm organization and experiences with livestock feeding.

It was found that about 28 percent of the cropland acreage was in alfalfa and pasture, 31 percent in row crops, and 31 percent in small grain crops. About 42 percent of the cropland acres were used to grow cash crops and the remaining acres used for feed crops.

Of the 64 farms in the sample, 34 farms irrigated all their acres and 30 farms had dryland farming integrated with irrigation. Sixty-nine percent of the farmers indicated a preference for the irrigation-dryland type of farm unit.

Labor problems were an important factor associated with irrigation type of farming because irrigation farming does not lend itself to mechanization as fully as dryland farming. Hired labor with irrigation experience was difficult to obtain. Livestock feeding provided year around employment for hired labor.

The three major types of livestock feeding enterprises found on the survey farms were beef, beef and lambs, and lamb feeding. Twenty-seven farmers reported having only a beef feeding enterprise, 12 farmers reported both a beef feeding and lamb feeding enterprises, and 25 farmers reported a lamb feeding enterprise only. Purchasing feeders rather than maintaining a breeding herd was preferred because of the flexibility for adjusting livestock numbers to the feed supply. Livestock enterprises utilized all home-grown feeds and some feed grain was usually purchased off the farm. Only about one-fourth of the farmers purchased hay off the farm.

The use of manure was considered an important item on the farms surveyed. Irrigated land that was not manured or rotated with legumes and other deep-rooted plants soon decreased in productivity.

Based on information from the Lower Yellowstone survey and other data, planning guides were determined for a model farm in north-central North Dakota. Optimum farm plans for a 640 acre farm, with 480 acres in cropland of which 160 acres can be irrigated were computed by the linear programming process. These results are summarized as follows:

1. When operating capital is very limited, the land should be farmed as a dryland unit, with all wheat acres seeded on summerfallow.
2. Invest funds for recommended fertilizer applications before going to irrigation or livestock.
3. If forages can be marketed for cash, highest profits are attained by investing in irrigation before livestock.
4. Buying feeders to feed out is the most profitable livestock system for investing extra dollars over and above what is needed for crop production, fertilizer, and irrigation of 160 acres.
5. When home-grown feed supplies limit livestock production, it is most profitable to shift feed grain acreage to forage production and purchase needed feed grains off the farm.

N. Dak. Agr. Expt. Sta., N. Dak. State U. Agr. and Applied Sci., Fargo, N. Dak.



Nohre, C. O., and Raup, P. M. REGULATION OF WATER USE IN MINNESOTA AGRICULTURE. Minn. Agr. Expt. Sta., Sta. B. 452, 23 pp. 1961.

Minnesota is richly endowed with water resources. Famed as the land of 10,000 lakes and the source of the Mississippi River. The State also possesses valuable ground-water reserves.

Despite this wealth in water, some areas and users face periodic water shortages. The growth of cities and the attraction that the state offers for recreation and to industries demanding large supplies of water have combined with traditional agricultural uses to focus attention on the adequacy of current and future supplies.

The dry years of the middle 1930's demonstrated that water is not always plentiful throughout Minnesota. Dry lake beds and falling ground-water levels showed the need for planning to avoid more widespread shortages. As a result, the Legislature established a water-use permit system. Under this system, users of water, with some important exceptions, must obtain written permission from the Department of Conservation through its Division of Waters.

This bulletin discusses the policies, procedures, and some of the problems that have emerged in administering this permit system. While permits are required for a variety of purposes, this bulletin places primary emphasis on those that authorize the withdrawal or "appropriation" of water for irrigation.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Schmid, A. A. MICHIGAN WATER USE AND DEVELOPMENT PROBLEMS. Mich. Agr. Expt. Sta. C. B. 230, 31 pp. 1961.

Michigan is a water wonderland with more than 36,000 miles of rivers and streams, 11,000 inland lakes, and 3,000 miles of Great Lakes shore line. How then can Michigan have water use problems? The problem is not one of absolute shortage but rather of not enough water at the right place, in the right quantity, at the right time, and at a reasonable cost.

Water is an important ingredient in the Michigan economy. The growth of population, a rising standard of living, and new water using technologies have placed increasing demands on water supplies. This increased demand for agricultural, industrial, municipal, and recreational use has created conflicts which will require Michigan citizens to make new policy decisions on how they want to use their water resources and how people with different interests can live together.

Michigan water use problems involve conflicts between irrigation and other uses such as recreation. It involves waste disposal conflicts, problems in establishing lake levels, and urban and industrial conflicts.

This bulletin is a discussion of some of the actual problems faced by Michigan people and what is being done to solve them both by informal agreements and by formal law. It includes consideration of the effects of water laws and whether they cover current problems.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

## Drainage

Donnan, W. W., and Aronovici, V. S. FIELD MEASUREMENT OF HYDRAULIC CONDUCTIVITY. J. Irrig. and Drain. Div., ASCE (IR 2): 1-13. June 1961.

One of the major factors connected with the design of drainage systems is the measurement of hydraulic conductivity of the soil strata to be drained. The work carried on to develop a device for this measurement is described. Laboratory studies resulted in the adoption of a small, brass, screen-type well point

which could be inserted in the soil below the water table. The rate at which water was pumped out of the well point related directly to the conductivity of the strata being tested.

Field-type well points were then developed, using ordinary hardware pipe fitting. The field well points were then tested in the laboratory and in the field with good results.

This report describes how to make the field well points and outlines a technique for field installation and operation of the device. Graphs are provided which relate quantity of water pumped under various head differentials with the corresponding hydraulic conductivity.

SWCRD, ARS, USDA, Pomona, Calif.

Schwab, G. O. HOW MUCH WATER DO DRAIN TILES REMOVE? Ohio Farm and Home Res. 46: 20-22, 1961.

To answer the question of how much water tile drains remove, a longtime experiment was installed in 1949 at the Tiffin State Hospital Farm at Tiffin, Ohio. This progress report gives the results from the experiment for the first 8 years, 1951-58.

The installation was located on a typical lakebed soil (Nappanee sil) that had topsoil depth of 8 to 12 inches. The experiment consisted of six different fields each of which included tile depths of 2 and 3 feet and spacings of 30 and 60 feet in all possible combinations. In four of the fields a 4-year good crop rotation, consisting of corn, small grain, and 2 years of meadow-alfalfa mixture, was established. In the remaining two fields a poor crop rotation, consisting of corn and small grain, was planted.

From the first 8 years of results the conclusions are as follows: (1) Tile flow varies considerably from month to month and from year to year. Rainfall does not vary nearly so much. (2) The highest monthly tile flow for the year occurred in March. (3) Corn in the poor rotation gave the highest tile flow. Corn and second year meadow in the good rotation gave the lowest flow due to low initial soil moisture conditions. (4) The flow from tile at 3-foot depths was greater than the flow from tile at 2-foot depths. (5) Flow from the 30-foot tile spacings was considerably greater than that from the 60 foot spacings. (6) Daily flow rates did not show consistent results regarding the best combination of tile depth and spacing. And (7) for corn in the poor rotation fields, tiled at 3-foot depth and 60-foot spacing, the time of flow for a 3/8-inch removal of water per day averaged about 1 day per season or 1 percent of the time during the 4-month period, March through June.

Ohio Agr. Expt. Sta. Wooster, Ohio.

Argyriadis, C. WATER-TABLE VARIATION IN DRAINED STRATIFIED SOILS OVERLYING AN ARTESIAN AQUIFER. J. Agr. Engin. Res. 6(1): 31-36. 1961.

An electrical resistance analogue was used to determine the effect of soil stratification on the height of the water-table at the midpoint between drains. The analogue represented a soil section overlying an artesian aquifer with four horizontal layers each possessing different permeability. The depth of the drains varied from 4 to 19 ft. and the permeability ratios between soil layers from 0.25 to 0.75. The effect of a low-permeability layer overlying the aquifer and underlying more permeable layers was examined for all permeability ratios, drain and aquifer depths, and was expressed in percent change in the height of the water-table above the drain plane.

Commonwealth Sci. and Indus. Res. Organ., Commonwealth Res. Sta., Merbein, Victoria, Australia.

Kirkham, D. SEEPAGE INTO DITCHES FROM A PLANE WATER TABLE OVERLYING A GRAVEL SUBSTRATUM. J. Geophysical Res. 65: 1267-1272. 1960.

The problem of flow of ponded water over a stratum of homogeneous soil overlying a stratum of gravel, the gravel in turn overlying an impermeable layer, is solved for the case in which equally spaced ditches penetrate into the gravel. Flow nets are obtained, as are formulas, giving the quantity of water seeping through the ground into the ditches. The theory shows that unless the ditches are closer together than about three times the depth of the stratum of soil overlying the gravel, the proportion of water entering the ditches through the ditch walls is small compared with that reaching the ditches by way of the underlying gravel stratum.

Iowa State U., Ames, Iowa.

Grover, B. L., Ligon, J. T., and Kirkham, D. OPERATIONAL CHARACTERISTICS OF THE LATERALS NEAR THE EDGE OF A TILE DRAINAGE SYSTEM. J. Geophysical Res. 65: 3733-3738. 1960.

A two-dimensional scale model was used in a study of the effect of an undrained area on the operation of laterals near the edge of a tile drainage system. The discharge, from the outside lateral only, was increased because of drainage from the undrained area. No effect of the undrained area on the water table between any of the laterals was observed, except for a negligible effect in a region within less than one-fourth of a lateral spacing from the outermost tile. This effect was only noticeable when the water table had fallen to a point level with the drains.

Iowa State U., Ames, Iowa.

Talsma, T., and Haskew, H. C. INVESTIGATION OF WATER-TABLE RESPONSE TO TILE DRAINS IN COMPARISON WITH THEORY. J. Geophysical Res. 64: 1933-1944. 1959.

An investigation of the performance of tile laterals, selected from farm drainage systems, is reported. Useful theories of water-table response to tile lines are briefly reviewed.

Average hydraulic conductivity was determined from in-place measurements by the augerhole and piezometer methods. The position of the impermeable layer was determined from textural examination of the soil and from piezometer measurements of hydraulic conductivity. The performance of laterals was investigated by simultaneous measurements of water-table height along lines at right angles to the tile and rate of discharge from the tile line.

It was concluded that Hooghoudt's theory is adequately supported where flow boundaries can be sharply defined. The field data also support Kirkham's analysis, where the physical assumption underlying this analysis is reasonably met. Field data on the rate of lowering of the water table generally support Glover's analysis, although some caution appears to be necessary when using his analysis for design in cases where there is an impermeable layer at a small distance below the tiles.

Comparison of the data with theory also shows that average values obtained of factors used in design and those indicating performance are satisfactory, though field variability is high. The adaptability of field data to theoretical simplifications is emphasized.

Water Conserv. and Irrig. Comn., Griffith, New South Wales, Australia.



Isherwood, J. D. WATER-TABLE RECESSION IN TILE-DRAINED LAND.  
J. Geophysical Res. 64: 795-804. 1959.

A high-speed digital computer was programed to obtain water-table recession in homogeneous tile-drained soil. Parameters considered were tile depth, spacing, barrier depth, hydraulic conductivity, and drainable pore space. Drain diameter was 6 inches. The midpoint water-table height was found to fall exponentially with time after a slower initial rate. Results presented graphically can be used for the rapid evaluation of the effectiveness of two drains. Tile spacing for any given surface drawdown rate can then be determined.

Dept. Engin., U. Calif., Los Angeles, Calif.

Grover, B. L., and Kirkham, D. A GLASSBEAD-GLYCEROL MODEL FOR NON-STEADY-STATE TILE DRAINAGE. Soil Sci. Soc. Amer. Proc. 25: 91-94. 1961.

The construction and use of a reduced scale model for studying the falling water table in non-steady-state drainage problems are described. A capillary fringe is accounted for in the model. Stratified soils may be simulated. It was concluded that the model can be used to obtain information which is valuable in drainage theory and design.

J. Paper 3874, Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Brooks, R. H. UNSTEADY FLOW OF GROUND WATER INTO DRAIN TILE.  
J. Irrig. and Drain. Div., ASCE 87(IR 2): 27-37. June 1961.

A solution to the nonlinear differential equation describing unsteady flow toward equally spaced drains above a horizontal impermeable boundary is presented.

The solution is compared with field data and a published numerical solution. The solution was found to agree with the field data and the numerical solution when the drain spacing was large relative to the depth of drains.

SWCRD, ARS, USDA, Fort Collins, Colo.

Swartzendruber, D. WATER FLOW THROUGH A SOIL PROFILE AS AFFECTED BY THE LEAST PERMEABLE LAYER. J. Geophysical Res. 65: 4037-4042. 1960.

Water movement through a water-saturated soil profile was analyzed on the basis of Darcy's law for a sectionally continuous hydraulic conductivity along a one-dimensional, downward flow path. The resulting relationships were used to assess the effect of the least permeable layer on the flow through the profile. The hydraulic conductivity of the least permeable layer did not control the flow.

A second analysis, based on a quantity defined as the hydraulic resistance, showed that the hydraulic resistance of the least permeable layer controlled the flow through the profile with much less error than the hydraulic conductivity. The error became negligible when the hydraulic resistance of the least permeable layer increased.

Purdue U., Lafayette, Ind.

Taylor, G. S., Goins, T., and Holowaychuk, N. DRAINAGE CHARACTERISTICS OF TOLEDO AND HOYTVILLE SOILS. Ohio Agr. Expt. Sta. Res. B. 876, 23 pp. 1961.

Small land areas (about one-half acre) have been utilized to study the drainage characteristics of Toledo and Hoytville soils. Both are fine-textured Humic Gley soils that are found in appreciable acreages in the lakebed area of northwestern Ohio and should be representative of the poorly drained clay soils which require tile drainage.

The following conclusions can be drawn from these studies: (1) Water table (WT) recession by tile drains is quite rapid in the backfill and in the soil a few feet on either side of the backfill. (2) During WT recession, the WT surfaces are nearly flat except in and near the backfill. (3) During the first day of recession, the rate of drawdown in tilled Hoytville soil is approximately twice as fast as in tilled Toledo soil. The faster drawdown rate is attributed to the higher conductivity in the Hoytville soil. (4) The calculated rates of water removal by tile drains is one and a half times greater in Hoytville than in Toledo soil. (5) Significant changes in soil moisture content following saturation of tilled Toledo and Hoytville soil occur only in the A horizon. And (6) based on changes in moisture contents, the equivalent conductivity of Hoytville and Toledo soils was 0.82 and 0.43 inch per hour, respectively. These rates are two or three times greater than predicted by the auger hole method or by the criteria based on soil morphological characteristics.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Evans, D. D., and Ashcroft, G. TILE DRAINAGE FOR LAYERED SOIL. Soil Sci. Soc. Amer. Proc. 25: 142-145. 1961.

The effect of a restricting layer (1-foot thick) on the flow of water to drain tiles was evaluated. The following factors were varied alone and in combination: (1) Depth to the restricting layer; (2) relative conductivity of the restricting layer to the surrounding soil; and (3) the depth of the drain. For all cases, a constant hydraulic head was assumed along the soil surface and within a gravel envelope surrounding the tile. An impermeable layer was considered to exist at 7 feet.

Drain flux was calculated for each case and compared to give the relative effectiveness of the drains at the selected depths. There is nearly a linear relationship between drain flux and depth of drain when the relative conductivity of the restricting layer to the surrounding soil is 1:10. For 1:100 and 1:1000 conductivity ratio cases, drain flux is nearly independent of depth. The surface intake rate distribution is presented for several cases. The calculations show that a sizeable tension extending over a large portion of the soil profile would be expected for several of the cases.

Oreg. Agr. Expt. Sta., Corvallis, Oreg.

Orlov, A. Y., and Izvekov, A. A. EFFECT OF DRAINAGE ON THE FOREST-GROWING PROPERTIES OF PEAT-HUMUS SOILS. Soviet Soil Sci. 2: 141-148. Feb. 1960.

The data show that draining the peat-humus gleylike soils by means of small ditches markedly altered aeration conditions to a depth of at least 30 cm., improved the ash and nitrogen nutrition of plants, and affected growth as early as the second year. As the roots penetrated the deeper horizons, the growth became still greater.

The draining of peat-humus gleylike soils is more effective in raising the productivity of forests than the draining of excessively waterlogged forest areas

with a thick layer of peat. With the use of comparatively simple drainage measures (small ditches), tree roots can utilize more nutrients in both the organic and mineral horizons. Since peat-humus soils are located on more or less definitely sloping surfaces, their drainage does not require the laborious job of digging large main ditches and the clearing of natural waterways. Observations showed that the peat-humus gleylike soils receive their excess moisture chiefly from higher lying areas of the locality. To remove this water, we do not need as dense a network of ditches as in the experiment described. By using the techniques of lumbering organizations on concentrated clear-cuttings to establish the networks of ditches, it is possible at small expense to increase substantially the productivity of the new forest generation over wide areas having peat-humus soils.

Amer. Inst. Biol. Sci., 2000 P. St. N. W., Washington 6, D. C.

Bobchenko, V. I. EFFECT OF MOLE DRAINS ON THE FERTILITY OF CHERNOZEM AND CHESTNUT SOILS. Soviet Soil Sci. 11: 1306-1311. Nov. 1959.

In a study of the effect of mole drains in Russia, the author made the following conclusions: (1) Artificial mole drains can be used for subsurface irrigation, accumulation of water, drainage, aeration, and as an agronomical measure for influencing the water, air heat, and nutrient regimes of the soil. (2) In the forest-steppe zone, annual digging of mole drains below the plow layer increases the yield of agricultural crops by 5 to 20 percent, and from the economic point of view it is a very effective agronomical measure. (3) Mole drains may be successfully used for subsurface irrigation in dry years. (4) The beneficial effects of mole drains on the soil combined with periodic subsurface irrigation constitute appropriate means for improving even on high yielding areas in the forest-steppe zone. (5) Since mole drains usually have a drying effect on soils in the steppe-zone, they should be applied only when there is ample moisture present. And (6) the feasibility of using mole drains for subsurface irrigation depends on the stability and resistance of the soil to water, and also on the method of digging and use of the drains. Methods for determining whether soils are suitable for digging stable mole drains are mentioned in this paper.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Maasland, M. WATER TABLE FLUCTUATIONS INDUCED BY IRRIGATION. J. Irrig. and Drain. Div., ASCE 87(IR 2): 39-58. June 1961.

The theory of intermittent recharge, as previously developed, is extended and analyzed. Equations are presented from which charts may be prepared for easy computation of drain spacings for irrigated agriculture. The analytical results may also be used to compute the effect of natural drainage on the height of the water table as well as anticipated changes in the water table of newly irrigated areas.

Tippetts, Abbett, McCarthy, Stratton, Engin. and Archts., 375 Park Ave., New York, N. Y.

Harrison, D. S., Stewart, E. H., and Spier, W. H. SOME CONSIDERATIONS FOR DRAINAGE OF FLATWOODS SOILS USED IN VEGETABLE PRODUCTION. Fla. State Hort. Soc. 73: 195-200. 1960.

Drainage or irrigation criteria depend on such factors as crop moisture requirements, soil topography and moisture characteristics, expected rainfall, and the economics of the various systems. For optimum production, vegetable crops require a soil environment in the rooting zone of near field capacity.



A 2-foot water table is generally considered to be best for most vegetable crops grown on Florida flatwoods soils with sub-irrigations. Flooding these crops for longer than 26 hours may seriously damage healthy plants. Moisture removed from the soil as evapo-transpiration under normal vegetable cropping conditions range from 0.1 to 0.2 inch per day.

Data on soil moisture retention and release by these soils are essential for determining drainage requirements. Generally, 2 to 3 inches of free water will need to be removed from these soils to lower the water table from the surface to 24 inches. Soils having a sandy texture to the depth of the drains usually have good internal drainage, but may present problems of ditch or drain-tile maintenance. Sandy loam or sandy clay subsoils usually have hydraulic conductivity rates much lower than fine sands. Whether to use ditch or tile drains largely depends on the hydraulic conductivity of the soils and the economics involved in land use and field operations resulting from open ditch construction.

A well designed ditch and tile drainage system for level to gently sloping land may be used in reverse as an affective sub-irrigation system. The irrigation system selected should be designed to supply sufficient water to bring the soil moisture to near field capacity in the plant rooting zone.

The first step in design of drainage is the determination of economic factors that set up the frequency which a crop can be lost to flooded fields.

Jr. Author, SWCRD, ARS, USDA, Fort Lauderdale, Fla.

### Evaluation of Flood Water Damage

Newton, D. W. STORMS AND FLOODS ON SMALL AREAS. J. Geophysical Res. 65: 2117-2123. 1960.

A complete analysis of the flood potential of a watershed must include an estimate of the maximum expected flood discharge. A simplified, easily applied procedure for areas of up to approximately 500 square miles is outlined. The procedure is based upon a determination of the maximum expected storm. Storm transposition techniques and information published by the U.S. Weather Bureau and the U.S. Army Corps of Engineers are used in making this determination. A basic family of depth-area-duration curves is found, by use of relationships developed by the U.S. Weather Bureau and reported in Hydrometeorological Report 33, to envelop observed storms in a meteorologically homogeneous region. These basic data are adjusted to conform to the moisture potential of the watershed in question. Standard techniques are used to compute the precipitation excess and the flood hydrograph. Support for this technique for computing both storms and floods in the Tennessee Valley area is found in observed events in the region.

Div. Water Control Planning, TVA, Knoxville, Tenn.

### Storage and Conveyance

Wilder, C. R. LOWER-COST CANAL LININGS THROUGH MECHANIZATION. Civil Engin. 31(6): 39-41. 1961.

About 25 percent of the water entering an irrigation system of unlined canals never reaches the farm, according to records analyzed by the U.S. Bureau of Reclamation. Losses in some unlined canals are much greater, and many large supply canals approach or exceed the classical loss of "1 percent per mile." Lining can conserve much of this water. Through mechanization, the cost of canal lining has been held reasonably constant since 1945, despite doubling of construction costs in general. New machines and improved controls have contributed greatly to this result.

Increased efficiency in water conveyance can, in many instances, be obtained through improvements to the canal system, which usually means some type of impervious lining. Engineers generally recognize that lining a canal is economically justified only when the annual benefits, including prevention of seepage, exceed the annual cost of the lining. The first cost of a canal lining has a very important bearing on the ratio of benefits to costs.

The quest for lower-cost canal linings started many years ago, but this article is confined primarily to developments since 1945.

Two important results of the work of the Bureau of Reclamation on this problem have been: (1) Elimination of reinforcing steel from substantially all concrete canal linings; and (2) relaxation of tolerances as to alignment and grade of concrete-lined canals.

Region. Conserv. Engin., Portland Cement Assoc., Los Angeles, Calif.

Lauritzen, C. W. PLASTIC FILMS FOR WATER STORAGE. J. Amer. Water Works Assoc. 53(2): 135-140. 1961.

Polyethylene and vinyl films are gaining wide acceptance as linings for irrigation canals and reservoirs, because they control seepage effectively and are low in cost. Among the prospective applications of these plastic films, low-cost storage would seem to be the most promising. The properties of these films, as well as the principles of their construction and examples of their use for water storage, are discussed.

The author concludes that: Many uses have been found for plastics. A recent development has been the use of film liners for ponds, small reservoirs, and tanks. Although this development has been directed toward irrigation storage, the liners have also been used for the storage of water for domestic use and for industry. The good performance of film linings for such applications would indicate their potential applicability in water works structures.

SWCRD, ARS, USDA, Logan, Utah.

Heinemann, H. G. SEDIMENT DISTRIBUTION IN SMALL FLOODWATER-RETARDING RESERVOIRS IN THE MISSOURI BASIN LOESS HILLS. U. S. Dept. Agr., Agr. Res. Serv. ARS 41-44, 37 pp. 1961.

Considerable data were obtained on 23 small reservoirs in the Missouri Basin loess hills. Stage-capacity, capacity replaced by sediment, and sediment distribution curves were drawn for each. These curves are discussed in detail, compared with one another, and various findings given.

After making numerous graphical analyses, the multiple regression method was used to develop an equation to predict the minimum elevation of the principal spillway for floodwater-retarding structures. The variables used in this equation are: (1) Total original storage depletion; (2) original "n" value; (3) total storage capacity; and (4) sediment sample volume weight. Application of the results of the findings is suggested when sedimentation principles are the only criteria.

Curves are presented and a description given for determining points and predicting the capacity replaced by sediment curve. A step-by-step procedure is given for drawing a sediment distribution curve, using the capacity replaced by sediment, and the original stage-capacity curves.

These findings should be limited in application to floodwater-retarding structures in the Missouri Basin loess hills.

ARS, USDA, Inform. Div., Washington 25, D. C.

# BASIC SOIL PROBLEMS

## Soil Physics

Lyles, L., and Woodruff, N. P. MOISTURE AND TILLAGE TOOLS INFLUENCE SOIL CLODDINESS. *Crops and Soils*. 13(4): 21. 1961.

Studies have shown that the percentage of soil particles greater than 0.84 mm. in diameter (1/30 inch) to be a simple indicator of a soil's loss potential by wind; the higher the percentage of large clods, the less the loss by wind action. A major aim in tillage operations is to form aggregates sufficiently large to resist movement.

Research was conducted at Manhattan, Kans., on two primary factors influencing clod formation--soil moisture and type of tillage implement. A silty clay loam soil was worked with a one-way disk, a 5-foot V-type subsurface sweep, and a moldboard plow at moisture contents of 8, 11, 19, 22, and 25 percent. Field capacity for this soil was 30 percent.

The moldboard plow formed a larger percentage of clods greater than 0.84 mm. in diameter throughout the range of moisture than the one-way disk or subsurface sweep. Above 12-percent moisture, the one-way disk produced more of these clods than sweeps.

Cloddiness increased under all three tillage methods as the moisture content of the soil decreased from about the 20-percent moisture level. Dry soil conditions were superior to wet conditions for producing the largest percentage of clods. Very large clods were formed at the 8 percent moisture level and 96 percent of this soil tilled with the moldboard plow was in clods larger than 1-1/2 inches in diameter.

The effect of moisture on the original clod size had largely disappeared later in the season after 12.7 inches of rain had weathered them. However, differences owing to tillage implement were still apparent.

SWCRD, ARS, USDA, Manhattan, Kans.

Kvasnikov, V. V. DYNAMICS OF SHRINKAGE AND EXPANSION OF INDIVIDUAL LAYERS IN A VERTICAL PROFILE, AND CHANGES OF SOIL POROSITY DURING CULTIVATION. *Soviet Soil Sci.* 10: 1235-1240. Oct. 1959.

A method to determine the shrinkage and expansion of individual layers of the soil profile is proposed.

By using this method on a leached chernozem at the field station of the Voronezh Agricultural Institute for a period of 7 years, the following facts have been established: (1) The processes which take place in individual parts of the vertical profile of a field can cause: shrinkage or expansion of all layers, or shrinkage of some of them and expansion of others; (2) the various directions and forms of expansion and shrinkage over the entire thickness and in individual layers of the vertical profile of a field depend on the methods of tillage and planting and by the presence or absence of vegetation in the given area; (3) determination of the extent of shrinkage and expansion of individual layers of fields assures a better choice of the equipment and depth of cultivation in the management of plowland and the planting of grain crops; and (4) when the initial total porosity, the particle density, and the capillary porosity of the soil, and current changes in the height of individual layers are known, it is possible to calculate directly in the field the changes in the total capillary and noncapillary porosity for a corresponding period of time.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.



Islam, M. A., and Islam, W. INFLUENCE OF SUGARCANE, PADDY, AND JUTE ON SOIL AGGREGATION. *Soil Sci.* 91: 19-21. 1961.

Influences of sugarcane, paddy, and jute crops on soil aggregation were studied. Soil samples from cropped and check plots were analyzed for aggregate and mechanical composition to find the extent of aggregation. The extent of aggregation was expressed as a stability index, or the sum of the positive differences between aggregate and mechanical analyses.

Sugarcane was found to significantly increase soil aggregation. Paddy and jute had no significant effect, although they showed a tendency to decrease aggregation. The capacity of sugarcane crops to increase soil aggregation is thought to be due to the production of soluble sugar.

Agr. Expt. Sta., Dacca, East Pakistan.

Sillanpää, M. THE DYNAMIC NATURE OF SOIL AGGREGATION AS AFFECTED BY CYCLES OF FREEZING AND THAWING. *Acta Agr. Scandinavia* II(1): 87-93. 1961.

The effect of freezing and thawing cycles on soil aggregation was studied by using soil aggregates of different sizes and origins. Natural occurring aggregates of 2.0 to 3.0 mm. and 0.25 to 0.83 mm. were used along with crushed aggregates of less than 0.25 mm. in diameter.

There was a distinctly different behavior of the three aggregate fractions during the first part of the freezing-thawing treatment. Toward the latter part of the experiment, all three fractions reached approximately the same level of aggregation. It cannot be stated whether or not the final level of aggregation was reached, but there was a slight indication that a further increase might still be brought about in cases where the aggregation capacity is known to have been high originally (2 to 3 mm. and <0.25 mm. aggregates).

The soil moisture content was kept near saturation and compression caused by ice crystals pushed the particles together. Ice crystal formation apparently does not follow the configuration of the pore spaces, but causes compression which tends to reform soil structural units according to the configuration of ice crystallization. Accordingly, in a well-aggregated wet soil the first effects of freezing are destructive, but with continued treatments it seems that soil structure accommodates to the configuration of ice crystallization and no further breakdown takes place.

Agr. Res. Cent., Helsinki, Finland.

Thames, J. L. MEASURING SOIL MOISTURE OVER LARGE AREAS WITH SINGLE INSTALLATIONS OF MOISTURE UNITS. *J. Geophysical Res.* 64: 257-262. 1959.

It seems possible that, with proper calibration, single installations of electrical soil-moisture units can be used to estimate moisture contents of outlying sites receiving similar amounts of rain but differing in vegetation and soils. In tests with data from northern Wisconsin and west-central Mississippi, predicted moisture contents agreed closely with those obtained by on-site measurements. Results were most accurate at seasons when the soils remained near the wilting point or near field capacity and were least accurate during periods of recharge.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Schleusener, R. A., and Corey, A. T. THE ROLE OF HYSTERESIS IN REDUCING EVAPORATION FROM SOILS IN CONTACT WITH A WATER TABLE. J. Geophysical Res. 64: 469-475. 1959.

Evaporation studies were conducted on three soil types (Fort Collins cl, Greeley l, and Loveland fs) in contact with a water table. For conditions of high evaporativity or increased depth to the water table, it was found that evaporation from the soils was not always in proportion to the rate of evaporation from a free-water surface. Under some conditions there was an inverse relation between evaporation from the soils and that from the free-water surface.

Analysis of upward movement of water from a water table in the absence of hysteresis effects does not provide a satisfactory explanation for this inverse relation.

A capillary tube model is used to explain qualitatively these results on the basis of reversals of changes in pressure in the soil water. This hysteresis phenomenon is believed to be responsible for reducing evaporation from soils in contact with a water table.

Dept. Civil Engin., Colo. State U., Fort Collins, Colo.

van't Woudt, B. D. WATER LEVEL CONTROL IN EVAPORATION PANS. J. Geophysical Res. 65: 4031-4035. 1960.

An attempt was made to develop a fixed-water-level pan evaporimeter utilizing the Mariotte principle and flanged overflow nozzles for rejecting rain. Owing to temperature effects, the Mariotte principle proved to be only partly satisfactory. The overflow nozzles showed curious meniscus behavior, depending on the shape of the rim. They were unsuited for the purpose and have been replaced by a float-operated ball and valve system. If a fixed water level in a pan is maintained, a shallow depth of water is necessary. This shallow depth causes the daily pattern of evaporation to closely follow daily air temperature fluctuation.

Hawaii Agr. Expt. Sta., Col. Agr., U. Hawaii, Honolulu, Hawaii.

van Bavel, C. H. M. LYSIMETRIC METRIC MEASUREMENTS OF EVAPOTRANSPIRATION RATES IN THE EASTERN UNITED STATES. Soil Sci. Soc. Amer. Proc. 25: 138-141. 1961.

A review of various methods to determine the evapotranspiration rate under field conditions is given. It is shown that the data collected by a suitable lysimetric method are the only ones that exist in quantity, which can be considered reliable.

The conditions which must be met by a lysimeter installation for the accurate and representative measurement of the evapotranspiration rate are reviewed. The exposure, as well as the moisture conditions in the soil of the lysimeter, must be representative of those in the surrounding area if realistic values are to be obtained.

Selected data from four locations in the Eastern United States are presented and compared. Data for grass cover under a variety of geographic and climatological conditions do not vary greatly from one another. Such dependable comparisons as are available between different crops show that the differences between corn, wheat, and meadow crops are small though not insignificant. The need for additional and adequate lysimetric measurements of evapotranspiration rates in the eastern half of the United States is discussed. The necessity for making pertinent meteorological measurements to aid in the generalization of the data is stressed.

SWCRD, ARS, USDA, Tempe, Ariz.

Stearns, F. W., and Carlson, C. A. CORRELATIONS BETWEEN SOIL-MOISTURE DEPLETION, SOLAR RADIATION, AND OTHER ENVIRONMENTAL FACTORS. J. Geophysical Res. 65: 3727-3732. 1960.

To extend the usefulness of a soil-moisture prediction method, solar radiation, temperature, and other environmental factors were studied in relation to moisture loss in the surface 12 inches of soil. Data were obtained in an upland meadow on loessial soil near Vicksburg, Miss. Comparisons were made only for drying periods, and only when soil moisture was in the wetter half of its range.

Highest correlations of single factors with moisture loss were obtained with soil temperature and evaporation-pan data ( $r = 0.79$ ), and with solar radiation ( $r = 0.76$ ). Values for air temperature, vapor pressure deficit, humidity, and wind were progressively lower. Correlations with soil temperature or evaporation-pan data were somewhat improved by the addition of other factors in combination. Highest correlation was obtained with a site-derived depletion curve ( $r = 0.85$ ) from the previous year.

Southern Forest Expt. Sta., FS, USDA, Vicksburg, Miss.

Whisler, F. D. AGRICULTURAL DROUGHT AND EXCESS SOIL MOISTURE IN EASTERN NORTH DAKOTA AND SOUTH DAKOTA. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 44, 30 pp. 1961.

Agricultural drought and excess soil moisture can be predicted under specified conditions of soil-moisture availability, evapotranspiration, and precipitation in eastern North Dakota and South Dakota.

In proceeding from east to west in eastern North Dakota and South Dakota the number of drought-days from May through September increased and the excess moisture decreased. The fewest number of drought-days was about 40. The findings point out the necessity of conserving the water resources in this area.

ARS, USDA, Inform. Div., Washington 25, D. C.

Mathews, O. R., and Army, T. J. MOISTURE STORAGE ON FALLOWED WHEATLAND IN THE GREAT PLAINS. Soil Sci. Soc. Amer. Proc. 24: 414-419. 1960.

Soil moisture and precipitation data for 25 locations in the Great Plains representing over 450 crop years were analyzed.

The average quantity of water stored during the fallow period of an alternate crop-fallow sequence was 3.96 inches or 16.3 percent of the precipitation. Only a few locations showed storage of as much as 20 percent. On annually cropped land, 2.02 inches or 23.6 percent of the precipitation was stored during the fallow period between crops.

Statistically significant positive correlation coefficients were found between total precipitation during the fallow period and inches of water stored, but generally not between total precipitation and moisture storage efficiency. There was a general negative relationship between water in the soil at harvest, and the quantity and percentage of subsequent storage. In general, storage efficiency decreased from the northern to southern Plains. The data emphasize the inefficiency in the use of water under even the best of present techniques of dryland farming in the Great Plains.

SWCRD, ARS, USDA, Beltsville, Md.



Holemen, H., Carlson, C. W., Lorenz, R. J., and Jensen, M. E. EVAPO-TRANSPIRATION AS AFFECTED BY MOISTURE LEVEL, NITROGEN FERTILIZATION, AND HARVEST METHOD. Trans. ASAE 4(1): 41-44. 1961.

The effects of nitrogen rates, clipping frequency, and soil moisture levels on evapotranspiration rate of brome grass and a brome-alfalfa mixture was studied on a Gardenia fsl soil. The work was summarized as follows:

1. Records of daily evapotranspiration rates for short periods showed no important difference in water use between low and high nitrogen rates.
2. The seasonal evapotranspiration rate varied significantly among the three moisture levels. The low, medium, and high moisture level plots averaged 13.2, 26.6, and 28.0 inches respectively. Hay plots used 4 percent more water than did pasture plots in 1955, but during 1956 there was no difference between them. There was no real difference in seasonal evapotranspiration by plots, which had received various fertility treatments even though the yields increased with nitrogen fertilizer rate. Over one-half of the water used from the 4-ft. soil profile was taken from the top foot of soil by the hay and pasture crops.
3. The medium moisture level plots were about as efficient as the high moisture level plots in their water use. In overall yield, the medium moisture level plots were similar to the high moisture level plots, and both greatly exceeded the dryland plots.
4. Water use efficiency of brome grass increased with nitrogen fertility rates for both harvest systems and all moisture levels during both years.
5. Water use efficiency values for the hay harvest system was about 50 percent higher than the pasture harvest system.

N. Dak. State U., Fargo, N. Dak.

Russell, M. B., and Peters, D. B. WATER USE BY ROW CROPS. Ill. Res. 3(1): 6-7. 1961.

Water use by row crops in Illinois largely depends on the amount of solar energy absorbed by the moist soil surface and the transpiring plant leaves. Under normal conditions, 50 percent or growing season is due to evaporation from the soil surface. Cutting down on evaporation would mean more efficient use of both summer rainfall and subsoil-stored water. Evaporation would be decreased if less energy were permitted to reach the soil surface or less vapor allowed to leave the soil.

When the soil surface is moist, increasing the number of plants per acre has only a minor effect on total water use. It may increase total use when evaporation is limited by lack of water rather than by lack of energy.

Soils differ a great deal in their ability to store and retain available moisture. The moisture-retention capacities of some typical Illinois soils are given in the following table. Group I soils illustrate how soil texture influences moisture retention.

Some Illinois soils have such dense subsoils that it is difficult or impossible for roots to penetrate them (Group II). They are typical of soils in northeastern Illinois which have glacial till subsoils of high density. Plant roots cannot easily penetrate the lower depths of these soils; hence the water stored there is largely unavailable for plant use.

The soils of Group III have moderately dense subsoils which are quite infertile. Research has shown that where these soils are adequately fertilized and good management practices followed, the water in the lower depths may be used by plants.

TABLE.--Available Moisture-holding Capacities of Some Illinois Soils

Soil type	Inches of available water	
	To depth of 5 ft.	In probable rooting depth
Group I		
Watseka loamy fine sand-----	2.3	2.3
Onarga fine sandy loam-----	8.7	8.7
Muscatine silt loam-----	11.9	11.9
Group II		
Swygert silt loam-----	8.4	3.5
Saybrook silt loam-----	10.6	6.6
Elliott silt loam-----	12.4	6.7
Group III		
Cowden silt loam-----	14.1	6.0
Cisne silt loam-----	14.4	5.4
Grantsburg silt loam-----	16.7	9.5

U. Ill., Col. Agr., Urbana, Ill.

Holt, R. F., and Van Doren, C. A. WATER UTILIZATION BY FIELD CORN IN WESTERN MINNESOTA. Agron. J. 53: 43-45. 1961.

Soil moisture extraction by corn was studied for two seasons in western Minnesota. The major results may be summarized as follows: (1) Water requirements for corn are greatest in the period from tasseling to kernel formation; (2) water usage by corn drops sharply after kernel formation; (3) available soil moisture and rate of water usage determine the depth to which plants extract water; (4) soils in western Minnesota are not completely recharged from the end of one growing season to the beginning of another; (5) most of the summer rainfall may be lost through evaporation; and (6) the interval from maturity of the corn crop to freeze-up is an efficient recharge period.

SWCRD, ARS, USDA, Morris, Minn.

McMillan, W. D., and Burgy, R. H. INTERCEPTION LOSS FROM GRASS. J. Geophysical Res. 65: 2389-2394. 1960.

Field studies were conducted for the purpose of measuring interception loss from an actively transpiring grass cover. Continuous records of evapotranspiration were obtained from a pair of floating lysimeters in a grass field. The grass cover on and around each lysimeter was sprinkled alternately. No appreciable differences were observed between evapotranspiration from wetted and from unwetted vigorous grass covers. Differences were significant when dead grass stubble was placed on and around the lysimeters.

The data indicate that evaporation from wetted leaf surfaces may replace all or part of normal transpiration and that the entire plant-soil system should be considered in evaluating interception loss.

U. Calif., Davis, Calif.

Finn, B. J., Bourget, S. J., Nielsen, K. F., and Dow, B. K. EFFECTS OF DIFFERENT SOIL MOISTURE TENSIONS ON GRASS AND LEGUME SPECIES. *Canad. J. Soil Sci.* 41: 16-23. 1961.

Established stands of three grasses and legumes, grown in a greenhouse, were subjected to flooding treatments consisting of soil moisture tensions of approximately 0, 25, and 40 cm. (0, 10, and 16 in.) of water which were equivalent to field conditions where the water table is at the soil surface, 25 and 40 cm. (10 and 16 in.) below the soil surface, respectively. Herbage and root yields were measured.

Grasses were more tolerant to flooding than were the legumes. The order of decreasing tolerance to flooding was: reed canary grass, timothy, brome grass, birdsfoot trefoil, Ladino clover, and alfalfa. The yields of grasses tended to increase with increasing moisture levels and with durations of flooding, and the yields of legumes tended to decrease with increasing moisture levels and with the duration of flooding.

The effect of flooding on yields was more pronounced on the first than on the second harvest. Highly significant positive correlation coefficients were obtained between total top and root weights of reed canary grass, birdsfoot trefoil, Ladino clover, and alfalfa. Corresponding correlation coefficients for timothy and brome grass were negative and highly significant.

Oxygen diffusion measurements indicated that, in general, the yields of legumes increased with increasing availability of oxygen whereas the yields of grasses showed a tendency to decrease. As the soil temperature under flooding conditions increased from 41° to 80° F., the forage yields usually decreased.

Canada Dept. Agr., Ottawa, Ontario, Canada.

Rowe, P. B., and Reimann, L. F. WATER USE BY BRUSH, GRASS, AND GRASS-FORB VEGETATION. *J. Forestry* 59: 175-181. 1961.

The differences in seasonal and annual evapotranspiration loss and water yield from deep soil beneath oak-brush, annual grass, and grass-forb covers were studied in San Dimas Experimental Forest in the San Gabriel Mountains of southern California.

The results indicate that water yield cannot be appreciably increased in years of low rainfall or from shallow soils--soils less than 3 feet deep--by converting oak-brush cover to grass. On deep soils--soils over 3 feet deep--conversion from brush to grass can result in appreciable increases in water yield during years of rainfall sufficient to wet through the soil and satisfy current evapotranspiration losses. The deeper the soil up to the depth brush roots can reach, the greater is the opportunity of increasing amounts of water yield.

Optimum increases in water yield are also dependent on management practices that maintain a protective mulch cover and prevent regrowth of brush or the invasion of forbs and other deep-rooted plants.

The management of vegetation to increase water yield is like farming. To be successful and economically feasible, it must be limited to areas with conditions of rainfall, soil, and vegetation capable of yielding the desired results.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Williston, H. L., and McClurkin, D. C. SOIL MOISTURE-SEEDLING GROWTH RELATIONS IN CONVERSION PLANTING OF OAK RIDGES TO PINE. *J. Forestry* 59: 20-23. 1961.

Loblolly pine seedlings underplanted in blackjack-post oak stands on loessial ridges in north Mississippi will survive and grow well, if released from hardwood competition immediately.



Plots on which all hardwoods were controlled had better seedling survival and growth and more soil moisture than did plots on which only the overstory or understory hardwoods were treated.

A hardwood overstory seems to offer slightly more competition to underplanted pine seedlings during the first three years than does a dense understory of hardwood brush. On plots where only the overstory had been removed, seedling survival and height growth were slightly better, and the top 2 to 3 inches of soil had significantly more moisture, than where only the understory had been eliminated. Where all hardwoods had been removed, a great increase in annual vegetation depleted the moisture in the 0- to 12-inch layer as rapidly as where only the overstory had been controlled.

Overstory vegetation appears to draw more moisture from the upper soil zones than does the understory. At depths of 2 to 4 feet, no difference could be noted in amounts of moisture removed by overstory and the understory.

Low shade from the understory suppressed pine seedlings more than high shade from the overstory.

Anything less than complete removal of hardwoods resulted in the need for a repeat release about three years after the initial treatment.

During the first three years following conversion, about 10 percent of the underplanted pines were damaged by falling hardwoods, but less than 1 percent of the damaged pines were killed.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Stoeckeler, J. H., and Curtis, W. R. SOIL MOISTURE REGIME IN SOUTHWESTERN WISCONSIN AS AFFECTED BY ASPECT AND FOREST TYPE. J. Forestry 58: 892-896. 1960.

Soil moisture in the top 2 feet of soil was significantly higher in a north-facing than in a south-facing slope on five different sampling dates along a transect in native timber across an east-west valley near La Crosse, Wis., in 1957. It was about twice as high on the north as on the south slope.

On the north slope there was a regular and systematic increase in soil moisture from top to bottom of the slope. On the south-facing slope the trend also appeared but was less consistent because of presence of shallow ledge rock on the upper third of the slope and the recharge effect of the runoff from that zone on the middle third of the slope.

The moisture content under a northern hardwood forest on a north slope was almost double that under a white pine plantation on the same aspect. In stands located on south-facing slopes, moisture content in a Scotch pine plantation was fairly similar to that in native oak woods. Since the volume growth in the pine plantation was 3.5 times as high as in the scrubby oak stand, type conversion on the drier slopes by reforestation would seem to be a means of greatly increasing timber production on the farmwoods in the area.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

McClurkin, D. G. SOIL MOISTURE TRENDS FOLLOWING THINNING IN SHORTLEAF PINE. Soil Sci. Soc. Amer. Proc. 25: 135-138. 1961.

In 19-year-old shortleaf pine plantation in northern Mississippi, thinning markedly increased available soil moisture in the middle and latter part of the growing season. In the second year after thinning, the moisture increase was associated with more rapid and more prolonged diameter growth. Regardless of the amount of moisture available, diameter growth rates decreased during periods of rapid soil moisture depletion.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

The strength of beds of soil aggregates, saturated and unsaturated, was measured with a ring shear machine. For saturated loose soil with free drainage, the cohesion and friction components and total strength are proportional to the applied normal load. When sheared under load, the soil compresses to an ultimate voids ratio after which there is negligible change. This ultimate state differs from the critical voids ratio for saturated clay in that it appears to depend on the strength of the individual aggregates as well as on the nature of the soil material.

In unsaturated soil, as the aggregates are strained, suction in the pore water increases. This suction acts as an equivalent applied load on the water-filled fraction of the soil, and increases its potential resistance to strain by an amount determined by the apparent coefficient of friction of the saturated soil. The ultimate voids ratio for the unsaturated soil at any load is higher than for the saturated soil.

Commonwealth Sci. and Indus. Res. Organ., Adelaide, South Australia.

### Soil Chemistry and Mineralogy

Greweling, T., and Peech, M. CHEMICAL SOIL TESTS. Cornell U. Agr. Expt. Sta. B. 960, 54 pp. 1960.

Chemical soil tests, when properly correlated with crop responses to various fertilizers on different soils, can provide valuable and otherwise unobtainable information to serve as a useful guide in fertilizer recommendations and in general diagnostic work.

This bulletin describes the soil testing methods employed by the Soil Testing Laboratory in the Department of Agronomy, New York State College of Agriculture at Cornell University, and outlines briefly the routine operation of the soil testing service in cooperation with the county agricultural agents. The soil tests described are modifications of the rapid microchemical soil tests developed by Peech and English, many of which, however, have been highly mechanized and simplified without sacrificing accuracy. The introduction of flame photometric methods has greatly simplified the determinations of both calcium and potassium. Light transmittance measurements by means of a photoelectric colorimeter have replaced visual color comparisons in many of the tests. In addition, methods for determining soil pH, the lime requirement of soils, the potassium-supplying power of soils and the water-soluble boron content of soils are described.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Peyve, Y. V., and Rin'kis, G. Y. RAPID METHODS FOR DETERMINING MICROELEMENTS AVAILABLE TO PLANTS IN SOILS. Soviet Soil Sci. 9: 1063-1070. Sept. 1959.

A collection of rapid methods of determining microelements available to plants is presented. These are simple methods practical for large scale use, but accurate enough to determine the microelements (Cr, Zn, Mn, Co, Mo, and B) available in soils.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Sperow, C. B. THE MOLYBDENUM CONTENT OF WEST VIRGINIA SOILS.  
W. Va. U. Agr. Expt. Sta. B. 443, 11 pp. 1960.

Eighty soil samples, representing 30 important soil series in West Virginia, were analyzed for total molybdenum.

The average molybdenum content of these soils was 1.76 p.p.m. total molybdenum. The soils derived from limestone or limestone and shale parent material and the finer-textured soils were generally above average in total molybdenum. The coarser-textured soils and those derived from the tilted sandstones, siltstones, and shales of the Ridge and Valley Province were below average in total molybdenum. The total molybdenum content ranged from 0.42 p.p.m. in an Ashby channery 1 from Mercer County to 11.70 p.p.m. in a Berks shaly sil from Berkeley County.

Most of the soils analyzed contained sufficient, but not excessive, total molybdenum. The total molybdenum content was lower than would be desired in the soils of the tilted formations of the eastern half of the State, particularly the Ashby, Litz, Lehew, Ungers, and Calvin series, and in some of the coarser-textured soil types, particularly of the Dekalb, Wellston, and Pope series.

Some samples of the Berks series contained relatively high amounts of molybdenum. However, no production of toxic forage would be expected except under exceptional conditions.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Fleming, J. F., and Alexander, L. T. SULFUR ACIDITY IN SOUTH CAROLINA TIDAL MARSH SOILS. Soil Sci. Soc. Amer. Proc. 25: 94-95. 1961.

Some soils of the South Carolina tidal marsh area develop high acidity when drained. On soil samples from these areas, pH values were lowered as much as 3 units on drying. Final values often ranged from pH 3.0 to 2.0 with an occasional value below pH 2.0. These soils contain up to 5.5 percent total sulfur.

The sulfur acidity problem in these soils is similar to the problem in soils called Kattekley (cat's clay) in Holland and by various other names throughout the world. It is postulated that sulfur from sea water was reduced forming sulfides which oxidize to sulfate on exposure to air-drying. If there are not enough alkaline earth carbonates, high acidity results.

Field identification can sometimes be made by the smell of  $H_2S$  from the disturbed soil, but often it is necessary to determine pH values before and after drying. Total sulfur percentage is also indicative.

SCS, USDA, Soil Survey Lab., Beltsville, Md.

Gorbunov, N. I. THE SIGNIFICANCE OF MINERALS FOR SOIL FERTILITY.  
Soviet Soil Sci. 7: 757-767. July 1959.

The importance and distribution of primary and secondary minerals in soils, the supply of nutrients, phosphate adsorption by minerals, and several other properties of fundamental importance for soil fertility were studied. The author concludes that:

1. The primary minerals (feldspars, micas, pyroxenes, amphiboles, etc.) found in soils are sources replenishing the nutrient elements in solution: potassium, calcium, magnesium, (probably microelements), etc. Clay and non-clay minerals, which are a very important part of the soil adsorption complex, are formed from primary minerals during weathering and soil formation. The primary and secondary minerals explain a number of soil properties: cation exchange capacity, swelling,  $P_2O_5$  adsorption, etc.



2. Of the secondary minerals in soils, hydrous mica is most widely distributed and is a source of potassium for plants. In the fraction of  $< 1 \mu$  diameter particles of sod-podzols and chernozems formed on quaternary materials, montmorillonitic minerals and hydrous mica predominate, with mixtures of sesquioxide minerals and rarely, kaolinite. The amounts and distribution of these minerals in the profile are different in chernozems and podzols. Also, there is usually more amorphous material in podzols. Chernozems and podzols formed on older materials contain significant quantities of kaolinitic minerals in the  $< 1 \mu$  diameter fraction. Krasnozems contain mainly kaolinitic minerals, goethite, and gibbsite. Hydrous mica predominates in the  $< 1 \mu$  diameter fraction of sierozems. Since minerals differ in chemical composition and physical chemical properties, their significance for soil fertility varies.
3. Data are presented on  $P_2O_5$  adsorption by amorphous and crystalline minerals--clays (kaolinite, halloysite, montmorillonite) and non-clays (goethite, gibbsite). The role of humic acids, which interact with minerals to reduce phosphorus adsorption, is shown.
4. Phosphorus adsorption by montmorillonite, halloysite, and kaolinite, after grinding to an X-ray amorphous condition, is nearly proportional to the  $SiO_2:R_2O_3$  ratios in the minerals. For example, halloysite and kaolinite have equal  $SiO_2:R_2P_3$  ratios, and they adsorb equal amounts of phosphorus after grinding to destroy the crystal structure. In montmorillonite, this ratio is only half as great as in kaolinite, and correspondingly it adsorbs about half as much phosphorus.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Thorup, R. M., and Mehlich, A. RETENTION OF POTASSIUM META- AND ORTHO-PHOSPHATES BY SOILS AND MINERALS. Soil Sci. 91: 38-43. 1961.

Laboratory investigations with potassium meta-phosphate in comparison with potassium dihydrogen ortho-phosphate were undertaken to study their retention by soils and minerals as affected by type of colloid, temperature, time of contact, and nature of cation and salts.

The principal results obtained were: Bentonite and soils containing predominantly 2:1 lattice minerals retained somewhat more P from  $KH_2PO_4$  and halloysite, kaolinite; and soils containing predominantly 1:1 lattice minerals retained somewhat more P from  $KPO_3$ . These differences were accentuated at higher temperatures ( $35^\circ C.$ ) and after 24 hours of shaking. This shaking period also coincided with maximum retention of P from both sources.

Retention of P from meta- and ortho-phosphate by homoionic soils decreased in the order  $Al > Ca > Mg > K > Na = NH_4$ .

Percolation losses of K from soils treated with different K salts decreased in the order  $KNO_3 = KH_2PO_4 > K_2HPO_4 > KPO_3$ .

Jr. Author, N. C. Agr. Expt. Sta., Raleigh, N. C.

Mortland, M. M. THE DYNAMIC CHARACTER OF POTASSIUM RELEASE AND FIXATION. Soil Sci. 91: 11-13. 1961.

The discussion and experimental work illustrate the dynamic nature of potassium release and fixation. Two parameters that may govern rate and direction of potassium reactions with 2:1 minerals are suggested. Experimental evidence showed that potassium release and fixation can occur simultaneously in a system containing a heterogeneous group of 2:1 minerals not in equilibrium with each other. The rate of potassium fixation was found to be inversely proportional to the initial potassium content of the clay minerals.

Mich. State U., East Lansing, Mich.

## Soil Biology

Pinck, L. A., Holton, W. F., and Allison, F. E. ANTIBIOTICS IN SOILS:  
1. PHYSICO-CHEMICAL STUDIES OF ANTIBIOTIC-CLAY COMPLEXES.  
Soil Sci. 91: 22-28. 1961.

Adsorption studies with 10 antibiotics on clay minerals and soils show that these antibiotics can be divided into three groups according to their reactions with clays; (a) strongly basic (streptomycin, dihydrostreptomycin, meomycin, and kanamycin); (b) amphoteric (bacitracin, aureomycin, and terramycin); and (c) acid (penicillin) or neutral (chloramphenicol and cycloheximide). The first two groups react to varying degrees to form complexes with montmorillonite, vermiculite, illite, and kaolinite. Only montmorillonite adsorbs and holds the acidic or neutral antibiotics, and then only in very small amounts. Bacitracin and aureomycin are shown to be unstable in the presence of alkaline clays, whereas terramycin is stable under these conditions. The amount of each antibiotic that is adsorbed by the various clays is given. These values vary from an average of 318 mg. per g. of clay for the amphoteric antibiotics on montmorillonite to 9 mg. for the strongly basic ones on kaolinite.

X-ray diffraction data for the antibiotic-montmorillonite complexes gave an average expansion of the  $c$  spacing of about 4.4 Å. for the strongly basic antibiotics and 7.6 Å. for the amphoteric ones, corresponding to monolayers and dilayers, respectively. In similar vermiculite studies, streptomycin, neomycin, kanamycin, aureomycin, and terramycin were adsorbed to a lesser extent, only partially filling the crystal lattices.

Adsorption studies with soils showed that the clay minerals in them reacted with antibiotics just as do the corresponding comparatively pure minerals. The approximate type and amount of the predominant clay minerals present in soils can be calculated from antibiotic adsorption values.

SWCRD, ARS, USDA, Beltsville, Md.

Raw, F. THE AGRICULTURAL IMPORTANCE OF THE SOIL MESO-FAUNA.  
Soils and Fert. 24: 1-2. 1961.

The soil fauna includes the microorganisms such as bacteria and protozoa and the meso-fauna such organisms as soil arthropods, nematodes and earthworms. One aspect of the agricultural importance of these groups relates to the effect of their activities on soil formation and soil fertility. Some groups are also important to agriculture as crop pests, vectors of disease, and in other ways.

The activities of the diverse members of the soil fauna differ qualitatively, as well as quantitatively, and qualitative differences may outweigh quantitative differences when assessing the importance of particular organisms. The nitrogen-fixing bacteria may form only a small part of the total bacterial population of the soil and their metabolic rate may be no greater than that of many other soil bacteria, but their importance to agriculture is immense because they perform the unique function of fixing atmospheric nitrogen. Earthworms are important because they are the principal natural agents in burying dead plant remains, mixing them with the soil, and accelerating decomposition to release plant nutrients. The accumulative effect of their activity is so great that their presence or absence can result in the development of two fundamentally different soil types, "mull" and "mor".

The importance of the direct effect of the meso-fauna on the release of plant nutrients from soil organic matter is still undecided. Some of the problems involved can be illustrated by aspects of the nitrogen cycle in soil. Soil microorganisms excrete ammonia as the nitrogenous waste product when converting soil organic matter into microbial tissue and energy, and this ammonia

may then be converted into nitrite and nitrate by further bacterial action. The meso-fauna similarly excrete nitrogen in forms such as ammonia, urea, uric acid, and other compounds which are readily converted to available nitrogen.

Estimates of the weight of bacteria in soil are difficult to make, but Russel (1950) estimated that the top 6 inches of an arable soil at Rothamsted would contain 1,500-3,500 lbs. fresh weight of bacteria per acre.

The weight of meso-fauna in most arable soils is relatively small because earthworms are not abundant there. In permanent grassland, their weight is considerable. The often quoted estimate of 1,000 lbs. per acre is almost certainly an under-estimate because the methods used to make it are now known to be inaccurate, and where more accurate methods have been used, e.g. Waters (1955), Raw (1959), earthworm populations of 2,000-3,000 lbs. per acre have been found.

No strictly comparable estimates for the total amount of nitrogen mineralized by soil bacteria are available because much of it is immediately mobilized. Jansson (1958) suggests that in a arable soil incubated at 15°C. with and without straw about 75 p.p.m. of nitrogen were mineralized in 66 days.

Rothamsted Expt. Sta., Harpenden, Herts, England.

McCalla, T. M. SOIL ORGANISMS INFLUENCE CROP PRODUCTIVITY. Nebr. Expt. Sta. Q. 8(4): 3-5. 1961.

Many of the cropping and tillage practices that a farmer uses are effective in crop productivity because of their influence on organisms so small that a spoonful of soil contains more of them than there are people living on earth.

When the soil is tilled, aeration is improved. Aeration is favorable for the growth of the nitrogen, sulfur, and iron oxidizing organisms. When the soil lacks oxygen, it is unfavorable as an environment for many plants.

Every practice or management system influences microbial activity. This influences the decomposition of plant residues, the availability of nutrients, and the soil structure. These all influence crop growth. The growth of crops determines the soil cover and the erosion protection afforded.

SWCRD, ARS, USDA, Lincoln, Nebr.

Stoeckeler, J. H. ORGANIC LAYERS IN MINNESOTA ASPEN STANDS AND THEIR ROLE IN SOIL IMPROVEMENT. Forest Sci. 7: 66-71. 1961.

Quaking aspen (Populus tremuloides Michx.) a post-fire pioneer species, is the most widely distributed broadleaf tree species found in North America. Formerly considered a weed species, aspen now occupies a significant position in the production of fiber, lumber, and specialty products.

Less appreciated is the important role of the species as a soil improver, and as a pioneer crop preceding the establishment of later more valuable stages of more tolerant sub-climax and climax types, notably balsam fir and sugar maple.

In stands of quaking aspen in northern Minnesota the litter per acre varied from about 3200 lbs. of oven-dry material in 33-year-old stands to slightly over half that amount in 10-year-old stands.

The combined weight of the F (partially decomposed litter) and H (well decomposed litter) layers varied from 17 thousand to 62 thousand lbs. per acre and was related to age of stand.

The H layer constituted as much as 70 to 90 percent of the weight of the entire organic layer. It is deduced that the forest fires which established the aspen stands did not destroy all of the organic layer of the previous stand but left a residue of around 17 thousand to 20 thousand lbs. of organic material per acre, or about half the weight of the combined F and H layers found in the sample aspen stands at age 40.



The net annual increment in weight of organic layers between ages 10 and 30 for 29 plots was about 825 lbs. per acre. It was calculated that from one-half to two-thirds of the organic matter produced was lost by incorporation into the soil or disappeared due to action of organisms and leaching.

The calculated average amount of nitrogen in the organic layers of 5 well established aspen stands was 188 lbs. per acre in the F layer, and 363 lbs. per acre in the H layer. It was estimated that repeat burns in stands of the type discussed, often consume about 370 pounds of nitrogen per acre, thus causing a setback in the ecological succession of the economically valuable climax species having rather high nutrient requirements.

Quaking aspen gradually restores the nitrogen in the surface layers of burned-over sites by deposition of leaf litter as well as restoring bases such as potash, calcium, and magnesium brought up by root action from lower levels.

The H layers in aspen stands growing on soils with an abundance of lime carbonate had a considerably higher content of available calcium and magnesium than those on the more acid soils. The former had a site index of 10 feet more or 16 percent greater, and a mean annual increment of 7 cubic feet or 12 percent more, per acre, than the more acid soils.

Paper 3969, Sci. J. Series, Minn. Agr. Expt. Sta., St. Paul, Minn.

Cameron, R. E., and Fuller, W. H. NITROGEN FIXATION BY SOME ALGAE IN ARIZONA SOILS. Soil Sci. Soc. Amer. Proc. 24: 353-356. 1960.

Algal and lichen crusts and subsurface soil samples were collected from virgin and cultivated areas and analyzed for nitrogen and carbon. These crusts were incubated in the laboratory to determine if nitrogen could be fixed with time under the conditions stated. Algae isolated from the crusts also were tested for nitrogen-fixing ability and quantitative information was obtained for some species in pure and mixed culture experiments. Species of algae belonging to the genera Nostoc Vauch., Scytonema Ag., and Anabaena were shown to fix atmospheric nitrogen. Certain coccoid forms may fix nitrogen. In the absence of Azotobacter, soil algae were shown to grow autotrophically and to contribute appreciably to the combined carbon and nitrogen status of Arizona soils.

Paper 558, Ariz. Agr. Expt. Sta., Tucson, Ariz.

Means, U. M., Johnson, H. W., and Erdman, L. W. COMPETITION BETWEEN BACTERIAL STRAINS EFFECTING NODULATION IN SOYBEANS. Soil Sci. Soc. Amer. Proc. 25: 105-108. 1961.

Competition between genotypes of Rhizobium japonicum was studied in the greenhouse by using chlorosis-inducing strains 76 and 94 to facilitate identification of strains recovered from the nodules of soybean plants. Chlorosis-inducing strains were individually mixed in varying proportions with each of nine normal strains and the mixtures were used as inoculants on the Hawkeye and Lee varieties.

Technique studies indicated that with rare exceptions a single nodule contained only one bacterial strain and that chlorosis of sorghum seedlings produced by a water extract of a nodule was reliable indication that the nodule contained a chlorosis-inducing strain.

Strain 76 had a pronounced competitive advantage over all normal strains regardless of the proportions of the strain in the mixtures. As little as 1.1% of strain 76 in the mixture with strain 38 caused 85% of the nodules. Strains 31 and 71 were more competitive against strain 76 than were the other normal strains. Chlorosis-inducing strain 94 was much less competitive against 8 of the 9 normal strains than was strain 76.

The extent of chlorosis of the soybean plants gave a rough estimate of the competitive relationships between strains. The varieties Hawkeye and Lee were essentially identical in response to the various mixtures.

SWCRD, ARS, USDA, Beltsville, Md.

### Soil-Plant-Animal Relationships

Tso, T. C., McMurtrey, J. E., Jr., and Sorokin, T. MINERAL DEFICIENCY AND ORGANIC CONSTITUENTS IN TOBACCO PLANTS: I. ALKALOIDS, SUGARS, AND ORGANIC ACIDS. *Plant Physiol.* 35: 860-864. 1960.

A deficiency in any essential element affects the normal metabolic system and thus disturbs the balance of the chemical constituents of a living plant. The relative differences in alkaloid, sugar, and organic acid contents in tobacco plants (*Nicotiana tabacum* L. var. Connecticut Broadleaf) due to the deficiency of one of the following elements: N, P, K, Ca, Mg, S, and B are reported.

The data indicate the drastic changes in the plant metabolic system due to such deficiencies. Manually and physiologically (-B, -Ca) topped plants showed a higher alkaloid content than plants given any of the other treatments mentioned above. Alkaloid formation is considered not simply as a function of total nitrogen available or of total nitrogen content in a plant. Amounts of various sugars and organic acids in the ethanol extracts and hydrolyzate fractions of plants given different treatments were reported. Untopped control plants appeared to have a higher total sugar content than others. Glucose seemed to indicate some relation to alkaloid formation, but not a total organic acid content than untopped control plants, which are the next highest group among all treatments. The high glutamic acid content in -B plants and its possible role in alkaloid formation are discussed.

It is impossible to generalize the metabolic role of those elements studied from the limited data; however, the important effect of each element on the plant is clearly indicated.

CRD, ARS, USDA, Beltsville, Md.

Tso, T. C., and McMurtrey, J. E., Jr. MINERAL DEFICIENCY AND ORGANIC CONSTITUENTS IN TOBACCO PLANTS: II. AMINO ACIDS. *Plant Physiol.* 35: 865-870. 1960.

The effect of mineral deficiency on the amino acid composition of tobacco plants is reported. An earlier withdrawal of certain elements during the plant growth period resulted in more severe symptoms and more prominent effects on amino acid composition than later withdrawal.

In general, deficiency of B, Ca, P, K, Mg, and S caused an increase in free amino acid content in the plants, but not in N-deficient ones. Less difference was observed in the amino acid content of the hydrolyzate fraction among mineral-deficient and control plants when deficiencies occurred at earlier stages of growth.

Considering each element, Ca and B deficiency appeared to have more effect than others. Mg also had a prominent effect on free amino acid content, but not in the hydrolyzate fraction.

Regarding the possible relation between free amino acid and alkaloids, the content of asparagine in the plants of each deficiency treatment appeared to show a positive relation to the alkaloid content in that treatment. A similar, but not so prominent, relationship between proline and alkaloid content was also indicated. Regarding glutamic acid, since the larger portion of it is included in organic acid fraction through ion-exchange process, the small amount left in

the amino acid fraction showed no significant relationship with alkaloid content, although such relationship was indicated in the organic acid fraction in -B plants.

CRD, ARS, USDA, Beltsville, Md.

Kabata, A., and Beeson, K. C. COBALT UPTAKE BY PLANTS FROM COBALT IMPREGNATED SOIL MINERALS. Soil Sci. Soc. Amer. Proc. 25: 125-128. 1961.

A water-soluble Co salt applied to soils will result in a greatly increased uptake by crop plants for a short period. Although most of this Co is retained in the soil, it gradually becomes unavailable and its effect may entirely disappear within 10 years. Since soil minerals are important factors in the Co supply to the soil solution the relative uptake of Co from substrates containing Co-impregnated bentonite, kaolin, hematite, and muscovite treated in a manner to exclude exchangeable Co was investigated.

The highest sorption of Co was found in muscovite, but the highest percentage of sorbed Co soluble in 0.1N HCl was found in the bentonite. Ladino clover and orchardgrass absorbed several-fold more Co from bentonite than from the other minerals, and there was a correlation between this uptake of Co and the 0.1N HCl-soluble Co in the bentonite-sand culture at the conclusion of the experiment. In all cases, the total uptake of Co was only a small fraction of the total supply of Co in the substrate.

U. S. Plant, Soil, and Nutrition Lab., SWCRD, ARS, USDA, Ithaca, N. Y.

United States Plant, Soil, and Nutrition Laboratory. COBALT DEFICIENCY IN SOILS AND FORAGES: HOW IT AFFECTS CATTLE AND SHEEP. U. S. Dept. Agr. L. 488, 5 pp. 1961.

The cobalt present in soils is derived from the rock from which the soil is formed. Soils developed on basic, dark-colored rocks that contain olivine and pyroxene usually provide ample cobalt for the crops growing on them. Certain other soils are developed on geological material that has been eroded, transported, and deposited on low-lying areas. In many cases, such materials lose a portion of their cobalt. Some sandy soils--especially the ground water Podzol soils developed on sandy materials--will be low in cobalt in the low-lying areas. Clays generally have higher quantities of cobalt than do sands.

The cobalt taken up by plants is related to the soil on which they grow and to the soil drainage. More cobalt is found in plants growing on poorly drained soils than on well-drained soils. Large quantities of organic matter on the surface help to maintain cobalt in forms generally available to plants. Many soils have been leached of the mineral material they originally contained.

A description of cobalt deficiency in soils and forages is given along with material on how cobalt deficiency affects cattle and sheep, and why they need cobalt.

Cobalt deficiency in ruminants can be corrected in the following ways: (1) Adding cobalt to the feed; (2) giving cobalt to the animal directly; (3) adding cobalt to salt; (4) applying cobalt to pasture soils; and (5) increasing the proportion of legumes in the forage.

To use either of the first two methods, ask a veterinarian or a druggist to prepare the proper cobalt solution. Because the quantities needed are so small, it is generally not practical to prepare home mixtures containing cobalt.

ARS, USDA, Inform. Div., Washington 25, D. C.



Peterson, N K., and Purvis, E. R. DEVELOPMENT OF MOLYBDENUM DEFICIENCY SYMPTOMS IN CERTAIN CROP PLANTS. Soil Sci. Soc. Amer. Proc. 25: 111-117. 1961.

Molybdenum deficiency symptoms in 6 important crop plants were developed, described, and photographed. Deficiency symptoms were developed in the first generation of broccoli, cauliflower, and tobacco; and in the second generation of corn, cotton, and soybeans.

With large seeded crops it was necessary to develop seed low in molybdenum before severe deficiency symptoms could be produced. In the case of corn and cotton, germination of the molybdenum-deficient seed was at a slower and lower rate than for seed adequately supplied with the element. First generation cotton plants which received nutrient solution purified of molybdenum developed abnormal bolls.

Jr. Author, Rutgers U., New Brunswick, N. J.

Hagstrom, G. R., and Rubins, E. J. COPPER AND MOLYBDENUM IN CONNECTICUT SOILS AND VEGETATION. Conn. Agr. Expt. Sta. B. 360, 27 pp. 1961.

The copper and molybdenum status of Connecticut soils and vegetation was surveyed in an attempt to relate differences in the concentrations of these elements in the samples to differences in the lithology of the parent materials, of the soils. Samples were collected from the Eastern Highlands and the Central Lowlands. Three broad types of parent materials were represented: (1) Metamorphic gneiss and schist; (2) sedimentary sandstone; and (3) igneous traprock. Soil and vegetation samples were collected from 21 areas presently under cultivation, and from 12 areas where there was no evidence of recent cultivation.

The total copper content of the soils analyzed ranged from 4.4 to 143.8 p.p.m. Some of the cultivated sandstone soils from the Central Lowlands contained abnormally high amounts of residual copper probably from previously applied spray materials. When these very high values are rejected, the range of copper in the soils sampled is between 4.4 and 35.5 p.p.m. The total molybdenum content of the soils was quite uniform, with values ranging from 0.4 to 2.1 p.p.m.

The results indicate that both the copper and molybdenum content of uncultivated soils and the molybdenum content of cultivated soils derived from gneiss and schist are higher than the concentrations found in the sandstone soils. Soils developed from traprock appear to be intermediate in their copper and molybdenum content. The soil samples did not show any definite relationships between pH and concentration of copper and molybdenum. In the uncultivated area, soil samples from gneiss and schist and from traprock had an apparent increase in copper content with increasing depth in the profile. Molybdenum content of soils derived from sandstone decreased with depth.

Copper content of forage crops and native vegetation ranged from 2.6 to 13.7 p.p.m. Although some of the cultivated sandstone soils contained excessively high amounts of copper due to residues of spray materials, the slight increase in copper in the forage crops growing on these soils was not proportional to the increase in the soil copper.

Definite relationships between soil pH, soil copper and molybdenum, and plant copper and molybdenum were not particularly noticeable. The relatively high copper content and low molybdenum content of the native vegetation samples might be due to the low pH of the uncultivated soils. The copper content of several of the forage samples was low when compared to some of the values reported in the literature. The range of molybdenum in the forage samples was from 0.2 to 2.9 p.p.m. The low copper and molybdenum content of some of the forage samples indicate possible deficiencies of these elements.

U. Conn., Col. Agr. Expt. Sta., New Haven, Conn.

Selenium in certain soils of the Great Plains and other areas of the West is recognized as the cause of "alkali disease" of domestic animals in the region. Range animals are most likely to be affected, particularly when the supply of good forage is limited and there is little opportunity for the animal to make any selection of forage types.

Soils associated with selenium trouble are derived, for the most part, from rocks of the Cretaceous age. Geology and mineralogy are related in important ways to the occurrence of selenium in rocks, soils, and plants. Highly seleniferous rocks are often of tuff, shale, or limestone groups. A vertical section of rock often shows wide variation of selenium content with depth. Considerable quantities of selenium are transported in the drainage waters of certain western streams.

Rainfall in excess of about 25 inches appears to be sufficient to leach out the readily soluble and available selenium. Irrigation after several years will leach substantial quantities of the element from the soils, thus reducing the hazard.

Although the presence of selenium in plants has long been suspected, it was not until 1933 that quantitative estimations were made in the U. S. Department of Agriculture. Many thousands of analyses have since been reported in the literature for the purpose of determining the presence of quantities toxic to either man or animals. It was soon learned that typical selenium accumulator plants such as some members of the Astragalus genus (a legume), woody aster (a composite), and Stanleya pinnata (a mustard) were commonly found on seleniferous soils. Other plants, such as the cereals, also take up appreciable quantities of selenium if the element is in an available form in the soil.

The form of selenium in plants has never been clarified. The quantities of selenium reported range from 0.1 p.p.m. to several thousand p.p.m.

Extensive studies of the effects of toxic quantities of selenium on animals have been made. Horses, cattle, swine, and poultry are all susceptible to selenium poisoning. Both chronic and acute conditions have been recognized. The pathology of these conditions are described. Symptoms of toxicity may appear in a few hours or after several weeks, depending upon the quantity of selenium ingested. Death generally occurs in the acute cases, but, lameness, loss of hair, refusal to walk, and consequent troubles are seen in the milder cases. Congenital malformations in lambs and chicks are commonly found. Lethal doses for several animals have been established.

No practical protective measures are available except to limit grazing in certain areas. On federally owned lands in South Dakota, enough dry forage is left in the late fall to provide early pasturage for animals the next spring. The use of arsenic as a drench will counteract the effects of selenium, but this method requires careful control.

Some current investigations of certain diseases, such as muscular dystrophy ("white muscle disease") in lambs and calves, exudative diathesis in chicks, and liver damage in rats, indicate that small quantities of selenium will prevent such troubles.

Methods for the chemical determination of selenium in different kinds of materials are given. These methods have been successfully used for more than 25 years as a means of determining selenium in soils, vegetation, and other materials. Methods for evaluating traces of the element are currently being investigated at several laboratories. Selenium compounds as insecticides are discussed and the dangers arising from their use noted.

ARS, USDA, Inform. Div., Washington 25, D. C.

Derbyshire, J. C., Gordon, C. H., Wiseman, H. G., Melin, C. G., Kane, E. A., and McCalmont, J. R. CHEMICAL QUALITY, FEEDING VALUE, AND STORAGE LOSSES OF ORCHARDGRASS SILAGE AS AFFECTED BY NITROGEN FERTILIZATION. U. S. Dept. Agr., Agr. Res. Ser. ARS 44-100, 5 pp. 1961.

A direct comparison was made of storage losses, chemical quality, and feeding value of first cutting orchardgrass direct-cut harvested as ON (untreated) and +N (400 lb./acre of ammonium nitrate) forage stored in two upright silos.

The application of nitrogen to orchardgrass 15 days prior to harvest resulted in a forage and silage high in protein and of decidedly inferior quality as judged by present standards of physical and chemical characteristics. The marked inequality of these silages could not be demonstrated in feeding and digestion trials where treatment differences were small and nonsignificant.

ARS, USDA, Inform. Div., Washington 25, D. C.

Crawford, R. F., Kennedy, W. K., and Johnson, W. C. SOME FACTORS THAT AFFECT NITRATE ACCUMULATION IN FORAGES. Agron. J. 53: 159-162. 1961.

The management, fertility, and environmental factors that affected the accumulation of nitrates in forages were investigated. The factors that had a major influence on the concentration of nitrate in the forages studied were: species, part of the plant, stage of maturity of the plant, level of nitrogen fertilization, and light intensity. (Soil moisture was not studied, but has been observed elsewhere to be very important.) These factors were found to be capable of causing an increase of at least 1 percent nitrate under field conditions.

The factors that had only a small effect on the concentration of nitrate in the forages investigated were: closely related species, varieties, time of nitrogen fertilization, kind of nitrogen fertilizer, lack of certain plant nutrients, and placement of nitrogen fertilizer. These factors were found to cause a maximum increase of about one half percent nitrate under field conditions.

Cornell U., Ithaca, N. Y.

Harris, H. E. A COMPARISON OF THREE SOURCES OF PHOSPHORUS. La. Agr. Expt. Sta. B. 539, 35 pp. 1961.

The effects of three sources of phosphorus, applied at different rates and times, on the yield, chemical composition, and nutritive value of a mixture of rye grass, Louisiana S-1 white clover, and Dallisgrass grown under field conditions were studied.

Significant differences in the dry matter production were obtained among the different phosphate treatments. The highest total yield of dry matter for two years (1953 and 1955) was 8,783 pounds per acre from the superphosphate series. This yield was obtained from the initial application of 300 pounds of  $P_2O_5$  per acre applied in the fall of 1952. The highest total yield of dry matter from the rock phosphate treatments was 6,246 pounds per acre. This yield was obtained from the initial application of 600 pounds of  $P_2O_5$  per acre.

Rock phosphate applied at the rate of 600 pounds of  $P_2O_5$  per acre appears to be comparable to triple superphosphate applied at the rate of 300 pounds of  $P_2O_5$  per acre for forage production.

The annual application of 60 pounds of  $P_2O_5$  per acre from triple superphosphate was not sufficient to maintain yields of forage under meadow conditions.

The crude protein content of the forage from all fertilized plots was above the minimum animal requirements in the spring and early summer. The growth, largely grasses, in September did not contain enough crude protein to meet the nutritive requirements of beef cattle.



The calcium, phosphorus, magnesium, and potassium contents of the forage decreased with the advance of growing. The magnesium content of the forage varied less with season than did the other mineral elements.

In all instances, the addition of phosphorus to the soil increased the phosphorus content of the forage. Only small increases in the phosphorus content of the forage were observed from additions above the 120 pounds of  $P_2O_5$  level in 1953.

A comparison of triple superphosphate and ordinary superphosphate at the 300 pounds of  $P_2O_5$  level shows that both sources supply phosphorus to the plants in approximately equal amounts. The residual effects from these two sources at this level appear to be equal at the end of the third year.

Phosphorus uptake was slightly greater from rock phosphate when no lime was applied. The percentage of phosphorus in the forage from the initial application of 600 pounds of  $P_2O_5$  per acre from rock phosphate with no lime was approximately the same as that from 60 pounds of  $P_2O_5$  per acre from triple superphosphate applied annually.

On the basis of an animal requirement of 0.13 percent phosphorus in forage, the forage harvested from all fertilized treatments was equal to or above the minimum requirements for beef cattle in April and June, but the harvested forage was deficient in phosphorus from all treatments by September. On the basis of an 0.18 percent phosphorus requirement in forage, the forage from the plots receiving less than 60 pounds per acre of available  $P_2O_5$  was deficient in phosphorus throughout the season.

The calcium content of the forage, 0.3 percent or more, appeared adequate from both limed and unlimed plots. The calcium-phosphorus ratios were considerably wider than the optimum ratio of 2:1, but the ratios obtained fall within the range of tolerable limits.

A significant positive correlation was found between yield and the amount of available  $P_2O_5$  applied per acre. Other correlations between the contents of the different mineral elements in the plant material were inconsistent.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Reisenauer, H. M., and Dickson, A. D. EFFECTS OF NITROGEN AND SULFUR FERTILIZATION ON YIELD AND MALTING QUALITY OF BARLEY. Agron. J. 53: 192-195. 1961.

Barley yields in three field experiments were increased by nitrogen and sulfur fertilization with a significant nitrogen x sulfur yield interaction. The higher rates of nitrogen fertilization decreased kernel size, increased barley, malt, and wort (liquid prepared with malt which after fermenting is used in the manufacture of beer and ale) nitrogen, and reduced malting quality. Sulfur fertilization had no effect on nitrogen content but increased the enzymatic activities of the malts.

Wash. State U., Pullman, Wash.

Kidder, R. W., Beardsley, D. W., and Erwin, T. C. PHOTSENSITIZATION IN CATTLE GRAZING FROSTED COMMON BERMUDAGRASS. Fla. Agr. Expt. Sta. B. 630, 21 pp. 1961.

A disease of cattle appeared in southern Florida following the flood of 1947. This disease was observed almost exclusively on bermudagrass pastures as an epidemic. Studies indicated that sunburn or some abnormal sensitivity to sunlight was involved. Reports from New Zealand and from South Africa described a similar disease in sheep and established a hypothesis for further study.

One of the normal by-products from the digestion of chlorophyll is a porphyrin called phylloerythrin. This is removed normally from the circulation by the liver and excreted with the bile. Whenever some factor inhibits the normal

excretion of phylloerythrin, it accumulates in the blood and produces sensitivity to sunlight in the non-pigmented areas of the animal. A jaundice or icterus caused by liver damage is involved in this disease and may precede the factors or sequence which inhibits the normal excretion of phylloerythrin.

Occurrence of photosensitization in South Florida followed periods when bermudagrass had been frosted. Several molds appeared on the dead grass in 3 to 5 weeks after a frost. The most prominent of these molds has been identified as Periconia minutissima Cla. Re-growth of green grass becomes available for grazing at about the time this mold sporulates on the dead grass. Cattle obtaining their forage from such pastures developed photosensitization.

In New Zealand, research has shown that facial eczema, a similar photosensitization disease of sheep, is produced when a fungus identified as Sporodesmium bakeri Syd. is present on the forage.

Since both icterus and photosensitization follow the consumption of moldy grass along with new green grass, the disease may be a mold toxicity, with icterus and photosensitization as effects or symptoms.

By following approved cultural practices and eliminating common bermudagrass, cattlemen in South Florida have successfully controlled photosensitization for a period of nearly 10 years. When cases occur, the treatment with sodium thiosulfate either intravenously or orally has alleviated the symptoms and reduced economic losses.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Fisher, V. J., Ralph, E. H., and Williams, D. B. EFFECT OF APPLE SOIL MANAGEMENT PRACTICES UPON GROWTH, FRUITFULNESS AND FRUIT QUALITY. Del. Agr. Expt. Sta. B. 336 (T), 31 pp. 1961.

Nine soil management systems, including sods, cover crops, and mulches, were evaluated with respect to influence on tree growth, yields, nutrient content of leaves, and several aspects of fruit quality. The systems were evaluated on Golden Delicious, Red Delicious, and Stayman Winesap apple trees, from the time they were set in the orchard as nursery stock, until they approached full bearing at the age of 16 years. The experiment was conducted on essentially level, Norfolk ls in southern Delaware.

Of the nine soil management systems employed, the following two caused considerably faster tree growth than the others: (1) Poultry manure applied under the trees in conjunction with a summer cover crop of soybeans; and (2) a heavy straw mulch in conjunction with a winter cover crop of rye. A ryegrass cover crop in winter without mulch promoted less-rapid tree growth during the first 8 years, but by the age of 14 years, these trees were as large as any in the experiment.

Sod management delayed tree growth in comparison with all other systems. Soybean cover crops with two commercial fertilizer programs, and a double cover crop system of soybeans in summer and a combination of rye and vetch in winter, resulted in intermediate rates of growth.

Yields were closely correlated with tree size, except that yields began to lag behind the growth rate under the mulch system after the age of 12 years.

Fruit quality was not greatly affected by the different soil management systems. There was a tendency toward increased cracking of Stayman Winesap apples under mulch (especially in a year when the incidence of cracking was relatively low), and under fall tillage. Fruit size was depressed slightly under sod management without mulch.

Leaf analysis indicated that certain soil management systems had an appreciable effect on the nitrogen, phosphorus, and potassium content of the leaves, and there was some correlation among these three elements and tree growth and yields. No differences occurred in the content of calcium, magnesium, manganese, boron, iron, or copper.

U. Del., Agr. Expt. Sta., Newark, Del.



The effects of heavy and light grazing and soil differences on the number and growth characteristics of big and silver sagebrush (*Artemisia tridentata* and *A. cana*) were studied near Miles City, Mont.

In 1949, 30 plots each 10 x 12 m. were established on 3 of the 5 major soil groups present and on both heavily and lightly stocked range areas. Plots were sampled in 1949, 1955, 1957, and 1959.

The areas were grazed from May 15 to late October. The climate, topography, soils, and vegetation of the study area are typical of a large portion of the Northern Great Plains.

On the heavily grazed areas stocking rates averaged 1.85 acres/A. U. M. and on the lightly grazed ones 3.33 acres.

Both growing season and annual precipitation averaged only 86 percent of the long-time means.

Results of the study indicate the following: (1) Number of plants per acre of big sagebrush was influenced as much by soil differences as by stocking rates. (2) Heavy grazing favored greater numbers of big sagebrush plants on upland soils, but on terrace soils stocking rate had no effect. (3) Light stocking consistently favored higher number of silver sagebrush on both upland and terrace soils. (4) Greater proportions of seedlings of big sagebrush and fewer mature plants (on basis of crown diameter) were present under heavy stocking than under light on the upland soils, but stocking rate had little effect on crown-class distribution on the terrace soils. (5) Higher proportions of seedlings and mature plants of silver sagebrush (on basis of crown diameter) were present on both upland and terrace soils under light stocking than under heavy during the early part of the study period. During the latter part the effects of stocking rate largely disappeared. (6) A continuous decrease in the proportion of shorter big sagebrush plants and an increase in the taller plants were observed under both stocking rates on both soil groups throughout the study. (7) Smaller proportions of the shorter big sagebrush plants and greater proportions of the taller plants were present under light grazing than under heavy on upland soils, but there was little or no effect of stocking rates on height class distribution on terrace soils. And (8) a trend was evident for a smaller proportion of the shorter silver sagebrush plants on the upland soils and a greater proportion of large plants on both soils under light stocking than under heavy stocking.

CRD, ARS, USDA, Miles City, Mont.

Beetle, A. A., Johnson, W. M., Lang, R. L., May, M., and Smith, D. R.  
EFFECT OF GRAZING INTENSITY ON CATTLE WEIGHTS AND VEGETATION OF THE BIGHORN EXPERIMENTAL PASTURES. Wyo. Agr. Expt. Sta. B. 373, 23 pp. 1961.

Many factors contribute to changes in range vegetation. Some of these are the direct effect of weather, principally rainfall, and the direct and indirect effects of grazing.

The production of herbage fluctuates from year to year with changes in weather. One of the first effects of intensifying grazing is earlier maturity of the vegetation. This is brought about when mulch, which keeps the soil cool and moist, is eliminated. Little mulch accumulates on heavily grazed ranges; its absence hastens warming of the soil and earlier development of the vegetation. Rauzi (1956) has shown through infiltration tests that the Owen Creek sil soils in the heavily used pastures in this study absorbed significantly less water for both the first and second 30-minute periods of infiltration tests than did similar soils in the lightly grazed pastures.



Some of the direct effects of grazing are illustrated by the reduction of vigor as measured by leaf height of Idaho fescue and by changes in cover and in production of the forage species. Soils influence the magnitude of the effects of grazing on plant vigor. On sedimentary soils no serious effect was observed until grazing approached the moderate rate. On granitic soils, even light grazing reduced plant vigor. The total herbage production is of greater importance than leaf height in determining the degree of use the vegetation will stand.

Idaho fescue is the most important forage species on the Bighorn pastures. It was found that Idaho fescue grazed seasonlong would maintain production at approximately 40 to 45 percent use and this was considered proper use. At proper use, animal gains are near optimum. Lighter rates of grazing result in higher gains per day but lower per acre gain. Heavy rates of grazing produce more gain per acre but less gain per day. If improvement in production is desired, some lighter degree of grazing would be necessary. Even though the effect of use on the production of Idaho fescue was different on the two soil types, it is significant that this degree of use was about the same on both soils.

Other desirable species in the pastures did not show definite responses to grazing intensity. Sandberg bluegrass and canby bluegrass, less desirable species, increased when grazing exceeded 40 to 45 percent use on Idaho fescue.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

Pratt, A. D., Davis, R. R., Conrad, H. R., and Vandersall, J. H. SOILAGE AND SILAGE FOR MILK PRODUCTION. Ohio Agr. Expt. Sta. Res. B. 871, 22 pp. 1961.

In 1957 and 1958, 24 Jerseys and 6 Holsteins were divided in two similar groups of 15 cows each and were fed alfalfa-brome silage or soilage. Both groups were subdivided to feed three levels of grain (zero, half, and full).

Soilage-fed (dry lot feeding of fresh grass) cows ate about one-half more dry matter and produced a third more milk than those fed silage made from a similar crop harvested at about the same average stage of growth. These differences in dry matter intake and milk production were highly significant. When no grain was fed, the soilage-fed cows produced over 900 pounds more milk than the silage-fed cows during 126 days.

Coefficients of digestibility of the dry matter determined with Jersey cows of each group showed the dry matter of soilage to be 63.5 percent digestible as compared with 55.3 percent on silage. Addition of grain at the half level raised the coefficient for silage to 58.5 percent and at the full grain level to 60.6 percent. Coefficients of digestibility of protein of fresh grass were 78.6 percent as compared with 63.6 percent for silage. Grain feeding did not alter the digestibility of protein appreciably for either the grass-fed or silage-fed groups. The digestible dry matter intake of the grass-fed cows was 56 percent greater than that of the silage-fed cows.

The greater yield of 4 percent F. C. M. due to soilage was highly significant because of the greater intake of digestible dry matter. Grain feeding definitely increased milk yield but no statistically significant difference was found between half and full grain groups. The differences in weight changes from the beginning to the close of the experiment on both soilage and silage between the levels of grain feeding were not significant.

Cows fed the full rate of grain substituted grain dry matter for either soilage or silage dry matter while feeding at the half rate. This substitution resulted in increased dry matter intake.

Cows fed soilage maintained milk flow to the end of the experimental period of 18 weeks at a higher rate than did those fed silage and produced an averaged of 950 pounds more after the experiment and before the lactation was completed.

There appears to be no difference in the conception rate due to the forages fed.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Huffman, C. F., and Duncan, C. W. CHEMICAL COMPOSITION, COEFFICIENTS OF DIGESTIBILITY, AND TOTAL DIGESTIBLE NUTRIENT CONTENT OF CORN SILAGES. Mich. State U. Q. B. 43(2): 261-269. 1960.

The average percentage composition of corn silages over a 17-year period from 1940 to 1956, inclusive, were: dry matter, 29.1; ash, 1.45; crude protein, 2.74; ether extract, 1.00; crude fiber, 6.21; NFE, 17.7; calcium, 0.075; phosphorus, 0.071; magnesium, 0.077; potassium, 0.34; and iron, copper, cobalt, manganese, and carotene as milligrams per kilogram (p.p.m.) 63, 4, 0.03, 8, and 5.3, respectively. The average pH of the silage was 4.0.

The average coefficients of digestibility for 8 of the silages were: dry matter, 66.8; organic matter, 67.8; and NFE, 73.4 percent. The mean digestible protein and TDN values were 5.1 and 68.6 percent, respectively.

The need for supplemental protein, calcium, and carotene (pro-Vitamin A) is indicated when corn silage makes up all or a large part of the total ration.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

### Soil Classification

Lotspeich, F. B., Secor, J. B., Okazaki, R., and Smith, H. W. VEGETATION AS A SOIL-FORMING FACTOR ON THE QUILLAYUTE PHYSIOGRAPHIC UNIT IN WESTERN CLALLAM COUNTY, WASHINGTON. Ecology 42: 53-68. 1961.

Vegetation as a soil-forming factor was studied under forest and prairie conditions on the Quillayute physiographic unit in the western part of the Olympic Peninsula, Clallam County, Washington. This physiographic unit consists chiefly of the Quillayute Prairie, with an adjacent narrow forested strip to the north, east, and west. Beyond the boundaries of the physiographic unit the landscape is also forested.

The soils and vegetation of this physiographic unit are developing under a temperate humid climate on a silty sediment deposited in a postulated estuarine environment. This material is glacial flour from the valley glaciers that were present in the western Olympics during late Pleistocene time. The source rocks are of Tertiary age and are composed chiefly of shales, graywackes, and arkoses.

The vegetation of the prairie is chiefly herbaceous and is dominated by Pteridium aquilinum var. pubescens. In the adjacent climax forest Tsuga heterophylla is the dominant arborescent species. It is believed that the prairie vegetation once covered the entire physiographic unit, and that plants of the climax forest were encroaching only with extreme slowness prior to disturbances introduced with agriculture. Evidence is presented for expansion of the prairie vegetation as a result of clearing and burning of the forest, and for expansion of the forest vegetation as a result of abandonment of plowed portions of the prairie. Picea sitchensis is shown to be a one-generation seral species in these latter areas.

In the Quillayute physiographic unit, soils are characterized by a high organic matter content in the surface horizon, and consequently by a high cation-exchange capacity. The entire profile is strongly acid, with a low degree of base saturation. Weathering of soil minerals in place does not appear to any appreciable extent. There is no subsurface horizon of accumulation of silicate clays or of oxides. Horizon differentiation is based almost solely on color differences related to soil organic matter.

The chief differences between the soils of the prairie and adjacent forest are color and composition of the organic matter. Color changes from the very dark gray of the prairie to dark reddish brown, after trees invade the prairie. Organic matter content is little different under the contrasting plant communities,

but the soil of the prairie does have higher nitrogen percentages than those found in comparable near-surface horizons under forest.

The soils of the Quillayute physiographic unit do not possess features of a podzolic soil other than an acid reaction, although they do occur in a latitude and under a forest vegetation where podzolic soils are commonly formed.

Wash. State U., Pullman, Wash.

Wilde, S. A., and Krause, H. H. SOIL-FOREST TYPES OF THE YUKON AND TANANA VALLEYS IN SUBARCTIC ALASKA. J. Soil Sci. 11: 266-279. 1960.

The region consists of flood plains, river terraces, low mountains, and dissected plateaux. Much of the area is covered with wind-blown, micaceous silt and fine sand. The summer of nearly 100° F. drops in winter to -70°. The mean annual precipitation is about 12 in. The important types of forest soils include lithosols and regosols, alluvial soils, melanized raw-humus soils, micropodzols, half-bog soils, lowmoor peat, highmoor bog soils, and tundra-forest soils. Forest cover consists of white and black spruce, tamarack, paper birch, aspen, and tacamahaca poplar, accompanied by Sitka alder, willows, Alaska rose, highbush cranberry, many heath shrubs of both American and Eurasian origin, mosses (largely of *Sphagnum* and *Hylocomium* genera), and lichen.

Spruce stands on productive loessial uplands and permafrost-free terraces yield as much as 15 Mbf. per acre. A comparatively rapid growth of trees on lithosols and regosols, attaining 0.3 cords per acre per year, is attributed to large differences between the day and night temperatures resulting in condensation of water on fissures and fragments of rocks. Highmoors, covering slopes up to 45°, and some half-bog soils support sporadic cover of dwarfed trees; these otherwise unproductive sites provide food and shelter for wildlife, an important item in Alaska's economy.

The immediate neighborhood of highmoor peat and alkali solochak soils, as well as the development of non-podzolic, melanized soils covered with thick raw humus, are among many paradoxes of the Alaskan environment.

Agr. Expt. Sta., Palmer, Alaska.

Shepps, V. C., White, G. W., Droste, J. B., and Sitler, R. F. THE GLACIAL GEOLOGY OF NORTHWESTERN PENNSYLVANIA. Pa. Geol. Sur., 4th Ser. B. G 32, 59 pp. and maps. 1959.

Northwestern Pennsylvania is covered with deposits of drift brought by continental ice sheets which invaded from the north and northeast. Ice moved down the Erie Basin as a major lobe known as the Erie Lobe and spread out into northwestern Pennsylvania twice during the Illinoian age and five times during the Wisconsin age of the Pleistocene Epoch.

Tills of the various advances are identified and separated into stratigraphic entities on the basis of leaching, texture, color, and soil profile development and are treated as rock-stratigraphic units.

The outermost drift of northwestern Pennsylvania is Illinoian in age and extends as a 2- to 14-mile-wide band from Beaver County at the Ohio-Pennsylvania border to Warren County at the New York border. Two drifts are found in this belt, an outer drift represented by very thin, discontinuous till and erratics; and an inner (younger), thin, but more continuous fine-grained till.

The Wisconsin drifts are Tazewell and Cary in age, but Tazewell drift was completely covered by later Cary drift and does not appear at the surface. The Tazewell ice deposited a pebbly, sand till (Mogadore Till). The outer margin of the Cary drift is marked by the Kent Moraine composed of sandy loam till and gravel. Behind the Kent Moraine is the Kent ground moraine of loam till



which blankets most of the surface of northwestern Pennsylvania, and numerous kames and kame terraces. North of this ground moraine area is the end moraine (the Lavery Moraine) of the next advance; it and the ground moraine behind it are composed of silt till and are named for the hamlet of Lavery. Behind and in part compounded with the Lavery Moraine is the Defiance Moraine of the next (Hiram) advance. The till deposited in the Defiance Moraine and in the ground moraine of this advance is a clay or silty clay till.

Still farther to the north and parallel to the southern shore of Lake Erie is the Ashtabula Morainic System, a series of an echelon end moraines composed of silt till and deposited by the Ashtabula advance, the last advance of Cary time and the last ice to enter Pennsylvania. The Ashtabula Moraines override the Defiance Moraine in part. Lake deposits laid down after the Ashtabula ice had retreated blanket the plain south of present Lake Erie.

Bur. Publications, Dept. Property and Supplies, Harrisburg, Pa.

Yassoglou, N. J., and Whiteside, E. P. MORPHOLOGY AND GENESIS OF SOME SOILS CONTAINING FRAGIPANS IN NORTHERN MICHIGAN. Soil Sci. Soc. Amer. Proc. 24: 396-407. 1960.

Detailed physical, chemical, and mineralogical studies were made on profiles representative of the McBride, Isabella, and Nester series. These are soils that were formed in calcareous sandy loam, sandy clay loam, and clay loam tills, respectively, in northern Michigan. They are bisequal profiles representative of the zonal Podzol group, intergrading to Gray Wooded soils. They each contain eluvial fragipan horizons (Eq) between the overlying illuvial humus sesquioxide horizon (Ihi) and the underlying illuvial silicate clay or textural horizon (It). Genesis of the Podzol sequum is characterized by high physical, chemical, and biological activities, while the underlying Gray Wooded sequum is characterized mainly by leaching of soluble materials and high physical activity such as eluviation, illuviation, contraction, and rearrangements of soil particles.

The fragipan is most strongly developed in the McBride. The fragipans occur at depths of 8 to 20 inches beneath the surface and are 6 to 24 inches thick. They are deeper and thicker in the soils formed in the moderately coarse-textured primary materials. The fragipans are grayer and more compact than adjoining layers. They have high bulk densities, are hard when dry, and firm when moist. When moist, the resistance of the materials studied to the penetration of a metal cone increases with clay contents up to about 15 percent. With higher clay contents their resistance decreases rapidly. The clay in these horizons is largely illitic but some chlorite and kaolinite are also present. The clay and silt form a dense matrix or bridges between the sand grains.

The alterations of the primary materials necessary for the formation of the pedogenetic fragipan horizons include: leaching of lime, eluviation of the finer expanding lattice clays leaving a residual concentration of the coarser nonexpanding clay, compaction of the layers by weight of the overlying layers or the tap roots of plants, and possibly some weak reversible cementation with soluble alumina.

The fragipan layers interfere with the movement of water and plant roots in the soil profile. Roots branch little in these layers and tap roots of alfalfa commonly zigzag through cracks in them.

J. Article 2531, Mich. Agr. Expt. Sta., East Lansing, Mich.

A combined study of regional stratigraphy, petrology, and paleocurrents was made of the Freda sandstone, Jacobsville sandstone, Bayfield group, Dresbach formation, and Franconia formation. Data pertaining to the location and nature of the source of the sediments were obtained primarily from petrology and directional sedimentary structures. Environmental reconstructions were based on patterns of lithologic variations, kinds of sedimentary structures, and heavy minerals.

The information indicates that the Northern Michigan highland extended through northern Wisconsin and northern Michigan and acted as a source of sediment from Late Keweenawan through Dresbachian time. The Freda formation accumulated in the Keweenawan basin, which was north of the northern Michigan highland approximately in the present site of Lake Superior but extended considerably farther to the southwest. Deposition took place in a flood-plain and lacustrine environment. Prior to the deposition of the Jacobsville-Bayfield sediments, the Keweenawan sequence was deformed and eroded, but the northern Michigan highland persisted as a positive area, and the shape and extent of the basin remained much the same. A lacustrine environment predominated in the central part of the basin, but much of the Jacobsville sandstone and Bayfield group undoubtedly represents fan deposits which merge northward into sediments of an alluvial plain. During Dresbachian time the northern Michigan highland remained as a positive area, but shallow seas invaded the Lake Superior region from the northwest and central Wisconsin from the south. Most of the Dresbach sediments accumulated in a beach environment, but in southern Wisconsin an offshore neritic environment predominated. Prior to Franconian time there was a widespread regression of the seas, and most of the region was subjected to subaerial erosion. By Franconian time the northern Michigan highland was reduced to a surface of low relief, and the seas re-advanced across the entire area from the southwest. An appreciable amount of the Franconia sediments accumulated in an offshore environment.

U. Kans., Lawrence, Kans.

Stricklin, F. L., Jr. DEGRADATIONAL STREAM DEPOSITS OF THE BRAZOS RIVER, CENTRAL TEXAS. Geol. Soc. Amer. B. 72: 19-35. 1961.

The Brazos River in a 250-mile segment of its interior valley (Waco to Knox City, Texas) is a degradational stream with diverse channel patterns and unevenly distributed alluvium, and the character of the alluvium indicates that valley deepening was also a dominant trait of the stream during the Pleistocene. This is indicated chiefly by several diagnostic properties of the alluvium which seem to be directly related to stream degradation acting concurrently with lateral planation and accretion. These properties serve as an excellent basis for interpreting the history of channel migration.

The erodibility of various pre-Tertiary strata, into which the Brazos is presently incised, accounts for differences in stream gradient, channel form, and sedimentary load and largely determines the type of stream pattern developed. Typical patterns of braiding and flood-plain meandering are confined respectively to soft bedrock in the distal upper and lower parts of the valley; incised meanders are developed in resistant strata of the lengthy intervening segment.

Alluvium which expands to form prominent terraces in the more erodible valley segments (two terraces in the upstream segment and three in the downstream segment) indicates extensive lateral planation of the stream during downcutting of soft bedrock. Four diagnostic properties of the alluvium point to such a history: (1) The deposits decrease upward in component size from gravel

to terminal silt or clay and represent the successive accumulation during channel migration of bed load, bank, and overbank-flood-plain deposits; (2) the average thickness of the alluvium, about 30 feet, is a function of stream-stage variation and equal to the vertical distance between channel bed and flood plain; (3) the terraces and underlying bedrock surfaces have two components of slope: a major cross-valley component related to lateral shifting of the stream and concurrent downcutting and a minor down-valley component imposed by the stream gradient; and (4) the terraces are normally unpaired because lateral planation and bank undercutting have precluded the formation of opposing valley-side counterparts.

Several lines of evidence besides that of the alluvium indicate that the "Seymour beds" and younger alluvium immediately west of Seymour, Texas, are lateral accretions of two streams--the northerly shifting Brazos and a westerly shifting former tributary of the Brazos. From the slope of stream-planed bedrock surfaces beneath the alluvium, successive channel positions of the two streams are reconstructed and show the pattern of shifting of the tributary, which eventually led to its diversion into the Wichita River system. The limited distribution of lenses of Pearlette ash in the Seymour indicates the approximate position of both streams at the time of a far-reaching ash fall during the middle Pleistocene (late Kansan or early Yarmouthian). According to these indicated positions, the bulk of the alluvium was deposited before the ash fall.

Shell Oil Co., P. O. Box 2099, Houston, Tex.

Bartelli, L. J., and Odell, R. T. FIELD STUDIES OF A CLAY-ENRICHED HORIZON IN THE LOWEST PART OF THE SOLUM OF SOME BRUNIZEM AND GRAY-BROWN PODZOLIC SOILS IN ILLINOIS. Soil Sci. Soc. Amer. Proc. 24: 388-390. 1960.

The morphology, range in expression, and occurrence are described of a clay-enriched layer (Beta horizon) found below the B<sub>2</sub> horizon of selected soils in the area of Wisconsin glaciation in northern Illinois. The Beta horizon, characterized by a darker color and an abrupt, irregular lower boundary, was more pronounced in coarser textured drift, in Gray-Brown Podzolic soils, and in well-drained members of soil catenas.

SCS, USDA, Urbana, Ill.

Bartelli, L. J., and Odell, R. T. LABORATORY STUDIES AND GENESIS OF A CLAY-ENRICHED HORIZON IN THE LOWEST PART OF THE SOLUM OF SOME BRUNIZEM AND GRAY-BROWN PODZOLIC SOILS IN ILLINOIS. Soil Sci. Soc. Amer. Proc. 24: 390-395. 1960.

Results are presented from laboratory investigations of Beta horizons (clay-enriched layers found below the B<sub>2</sub> horizons) of selected soils in the Wisconsin-age glaciated region of northern Illinois.

Stereoscopic microscopic investigations indicated the peds were microconstructional. This was interpreted to be the result of not only the arrangement of skeletal material in situ, but also the effect of colloidal material which has moved into the horizon from above and deposited on surfaces of grains, peds, and walls of pores to alter the microconfiguration and porosity. Microscopic studies of thin sections showed a rather porous fabric with a large percentage of clay being strongly oriented in layers along surfaces of mineral grains, walls of pores and root channels, and surfaces of peds. Thin sections of sand columns through which clay suspensions had been passed had a fabric markedly similar to that of Beta horizons. These micromorphological investigations strongly suggest that the Beta horizon is primarily a zone of clay illuviation.

Mechanical analyses indicated that the total clay fraction (<0.002mm.) was at a maximum in the B<sub>2</sub> horizon and that fine clay was at a maximum in the Beta horizon of each profile. Amounts of organic matter by weight were about



the same in the B<sub>2</sub> and Beta horizons. If amounts of clay and organic matter were expressed on a specific surface area basis, the Beta horizon was appreciably higher than the B<sub>2</sub> horizon of the same profile.

Clay mineral analyses indicated that the Beta horizons are characterized by a montmorillonitic suite more closely associated with the loess-influenced material in the upper part of the soil than an illitic clay suite which characterizes the drift material below.

The reaction ranged from pH 6.0 to 7.7 for most of the Beta horizons with the lower portion of the horizon having the highest pH.

Clay migration was suggested as the dominant process in the development of the Beta horizon and it was closely related to the discontinuity in moisture flow at the boundary of the coarser textured substrata and finer textured subsoil.

SCS, USDA, Urbana, Ill.

Stuart, D. M., Fosberg, M. A., and Lewis, G. C. CALICHE IN SOUTHWESTERN IDAHO. Soil Sci. Soc. Amer. Proc. 25: 132-135. 1961.

Deposition of caliche in the soils of southwestern Idaho probably results from soil-forming processes. Caliche occurring on the lower, intermediate, and upper terraces of the Boise and Snake Rivers is described. Close correlation of the present ground surfaces with the top surfaces of the caliche layers is found. The pedogenic development of the soils is related to the ages of the terraces on which the soils occur, and also to the thickness and induration of the caliche layers. The thickness of the C<sub>ca</sub> horizon decreases or disappears entirely as the age of the soil and terraces increases. Calcium carbonate and silicates increase in the caliche horizons as the soils and terraces increase in age.

SWCRD, ARS, USDA, Logan, Utah.

Gile, L. H. A CLASSIFICATION OF CA HORIZONS IN SOILS OF A DESERT REGION, DONA ANA COUNTY, NEW MEXICO. Soil Sci. Soc. Amer. Proc. 25: 52-61. 1961.

A ca horizon is defined in the Soil Survey Manual as an accumulation of calcium carbonate. Field study in Dona Ana County, New Mexico, shows that ca horizons occur in soils on a variety of sediments and geomorphic surfaces. A broad fan piedmont extends from the Rio Grande Valley eastward to the igneous Organ Mountains. To the north, there is a desert bolson. In soils on these surfaces and in paleosols underlying the fan piedmont, ca horizons occur and range from thin CaCO<sub>3</sub> coatings on pebbles or few CaCO<sub>3</sub> filaments to indurated horizons many feet thick.

In soils of the study area, ca horizons have been classified as weak, moderate, strong, and very strong. The classification is based on field morphology and pertinent laboratory data, including CaCO<sub>3</sub> equivalent, particle size distribution, bulk density, unconfined compressive strength, and infiltration rate.

SCS, USDA, University Park, N. Mex.

Raychaudhuri, S. P. NEW SYSTEMS OF CLASSIFICATION AND NOMENCLATURE OF SOILS. J. Indian Soc. Soil Sci. 9(1): 1-8. 1961.

This is a discussion of the United States Department of Agriculture's system of soil classification (7th Approximation) and the New Russian System of practical soil classification. A tentative classification of Indian soils is given for consideration by soil workers in other countries to compare with the other two systems.

Indian Agr. Res. Inst., New Delhi, India.

Petrov, Y. G. A MECHANIZED AUGER FOR SOIL SAMPLING. Soviet Soil Sci. 8: 969-970. Aug. 1959.

A mechanized soil probe that can be carried on and then operated by a motorcycle is described and illustrated. This is used in Russia.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Fulgham, R. E., and Vanderford, H. B. JACKSON COUNTY SOILS. Miss. Agr. Expt. Sta. B. 622, 23 pp. 1961.

The soils of Jackson County are described in detail. This report is intended for use with a special soil map of any farm or area of land which may be obtained from the Soil Conservation Service or the County Agent's office in Pascagoula, Miss.

This bulletin is published to help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid foresters in managing woodlands; add to the soil scientist's fund of knowledge; and aid teachers of science in public schools.

Miss. State U., Agr. Expt. Sta., State College, Miss.

Fosberg, M. A., Lewis, G. C., Leighty, W. J., and Chugg, J. C. GEM COUNTY SOILS: PROFILE DESCRIPTION AND LABORATORY DATA. Idaho Agr. Expt. Sta. B. 360, 44 pp. 1961.

Characterization studies were made to supply basic information on Idaho soils. These data are useful for many types of soils interpretations relating land use and research investigations. They are field and laboratory data that describe the soil series and type in terms of its profile description, and chemical and physical characteristics. The studies were made in conjunction with the Gem County Area soil survey.

SCS, USDA, and Idaho Agr. Expt. Sta., U. Idaho Col. Agr., Moscow, Idaho.

Wascher, H. L., Alexander, J. D., Ray, B. W., Beavers, A. H., and Odell, R. T. CHARACTERISTICS OF SOILS ASSOCIATED WITH GLACIAL TILLS IN NORTHEASTERN ILLINOIS. Ill. Agr. Expt. Sta. B. 665, 155 pp. and maps. 1960.

Data from physical, chemical, and mineralogical analyses and field studies are used to characterize 33 representative soil profiles of 17 different soil series from three Great Soil Groups--Gray-Brown Podzolic, Brunizem (Prairie), and Humic-Gley.

Because of the important role glacial till plays in the identification and classification of the soils, considerable information is presented characterizing the kinds of glacial till in northeastern Illinois. Different kinds of till result in differences in the morphology of the soil profiles--the key to proper soil classification in this area.

Included in the illustrations are two color plates showing differences in till textures and in soil profiles. A table of correlated soil series is given along with a colored map showing location and extent of areas of soils associated with loamy gravel, sandy loam, loam and silt loam, silty clay loam, silty clay, and clay textures of till. This map also shows areas of soils developed from medium- and fine-textured water-deposited sediments as well as wind- and water-deposited sandy materials.

Detailed field descriptions and laboratory data are given and a list of references to related studies is included.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

# EROSION CONTROL

## Erosion Equation

Soil and Water Conservation Research Division. A UNIVERSAL EQUATION FOR PREDICTING RAINFALL-EROSION LOSSES--AN AID TO CONSERVATION FARMING IN HUMID REGIONS. U. S. Dept. Agr., Agr. Res. Serv. ARS 22-66, 11 pp. 1961.

Scientists have developed a soil-loss predicting equation that promises to be a significant contribution to safe, productive use of the Nation's soil. The equation's chief merit is versatility--it can be used wherever rain causes significant erosion losses. Its value in predicting longtime, localized soil losses has been established. It can be used to define the conservation practices needed for a given field to limit soil losses to tolerable levels. It provides a mathematical approach to conservation farm planning.

The new equation reflects the influence of all the major factors known to influence rainfall erosion. It is as follows:  $A = RKLS^2C/P$ .--where A is the average annual soil loss in tons per acre predicted by the equation; R is the rainfall factor; K is the soil erodibility factor; LS is the length and steepness of slope factor; C is the cropping and management factor; and P is the supporting conservation practice factor (terracing, stripcropping, contouring.)

How these factors affect erosion and how numerical equivalents for them were established are discussed. Also discussed are soil-loss tolerance values, which help make the equation more practical.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Wind and Water Erosion

Johnson, W. E. WIND AND WATER EROSION--IN WESTERN CANADA. Agr. Inst. Rev. 16(3): 12-15. 1961.

The damage due to wind and water erosion in Western Canada has not been assessed by systematic surveys to determine actual acreages affected and degree of erosion. Estimates available show considerable variation due largely to the method of interpretation and the absence of completely satisfactory criteria for assessing erosion damage.

The information available indicates that the erosion hazard is neither slight enough to justify complacency nor severe enough to warrant any "blue ruins" approach.

Moderate erosion has been a problem and continues as a potential threat on 5 to 10 percent of the present cultivated acreage. Severe erosion affecting local areas occur on 1 to 2 percent of the cultivated acreage.

The climatic conditions in the Prairie Provinces combined with the large summerfallow acreage of the present farming pattern cause wind erosion to be a continuing threat. Two major categories of soil require most attention.

Sandy-textured soils in all regions present a continual hazard under cultivation. On the brown and dark brown sandy soils of Alberta and Saskatchewan and on the sandy soils of the Souris basin in Manitoba, the condition has been considerably ameliorated by the retirement of large acreages to grass in the past 25 years. There are probably 3,000,000 acres of this soil category which should be placed in long-term grass production if continued damage to these and neighbouring areas is to be prevented. Of major importance at present are the sandy-textured soils of the black, dark grey, and grey soil areas. In recent years, damage has been relatively greater on these soils than on similar soils in the



prairie region. These sandy soils have some advantage over the sandy soils of the prairie in moisture efficiency, but have the added problem of somewhat lower fertility. The acreage in this category is probably between 1,500,000 and 2,000,000 acres.

Wind erosion damage has been widespread on the heavy clay soils of the prairie area and on silty-textured soils in all regions. These soils represent the most productive soils for grain, and continued improvement in control is necessary to maintain the high productivity of these soils.

Except in local severe erosion areas, water erosion tends to receive generally less attention from farmers than does wind erosion. In all provinces, there is an immediate need for improved control of water erosion. Water erosion is important on many of the more productive soils in all provinces.

Water erosion control is necessary for two reasons. Prevention of soil losses may appear to be the main goal. Control of water run-off, however, represents an important phase of moisture use and conservation. On land subject to water erosion, the retention of an additional half-inch of water by control methods represents a large contribution to productivity.

Programs for control of severe gully erosion are active in most provinces, but adequate control of slight to moderate water erosion is not as far advanced. Satisfactory control requires an increase in the use of sod crops and improvement in farm field arrangement.

One can conclude that erosion is an important problem, even if not the major one in Western Canada. Methods of control are well known and can be applied. There appear to be two main areas of weakness in programs for erosion control: Accurate data based on productivity losses and surveys of erosion are not adequate; and research is needed to provide better guides to programs in specific problem areas. In the applied field, accurate appraisal of control practices for their practical and economic use by farmers is essential for more general acceptance of recommendations for erosion control.

Saskatchewan Dept. Agr., Regina, Saskatchewan, Canada.

Ripley, P. O. WIND AND WATER EROSION PROBLEM AND PREVENTION IN EASTERN CANADA. Agr. Inst. Rev. 16 (3): 9-11, 15. 1961.

A 1961 estimate by soil surveyors in the 6 provinces of Eastern Canada indicates that, of some 23,500,000 acres of improved farmland in the area, 70 percent has suffered from little or no erosion, 26 percent from moderate erosion, and 4 percent from severe erosion. The 70 percent or 16,500,000 acres with little or no erosion presents no problem. The moderately-eroded land represents slightly over 6,000,000 acres on which the loss of productivity has been estimated to range between 10 and 35 percent. The severely-eroded land comprises 1,000,000 acres on which productivity has been reduced by more than 35 percent.

In an experiment at Ottawa where 264 tons per acre of soil were lost in 12 years when corn was planted up and down the slope, only 41 tons were lost when the corn was planted on the contour or across the slope. Under the same set of conditions, where alfalfa was grown continuously, only 49 tons of water were lost and 0.1 tons of soil were lost. The alfalfa crop gave almost complete control of erosion on this highly erodible soil.

The number of acres of total farmland in Eastern Canada is 42,684,142. Seventy-one percent of this land is devoted to the production of crops grouped as good for erosion control.

Crops intermediate for erosion control occupy only 12.16 percent of the total farmland. This is a total of 5,194,438 acres.

Other land not included above is occupied by farm buildings, lawns, lanes, and small area crops like peas and sugar beets which have not been included in the estimates.

It is in the areas of moderate and severe erosion that the greatest damage is done. Where severe erosion occurs and productivity is seriously reduced, it may be necessary to retire the land from agriculture and use it for some other purpose, or abandon it altogether. Certainly, where slight or moderate erosion occurs, control measures such as contour cultivation and cropping, strip cropping, grassing, reforestation, and in special cases terracing, can be adopted to greatly reduce, if not completely control, erosion. Once the erosion is controlled, the previously eroded land can be brought back to good productivity by better soil management practices.

Res. Br., Canada Dept. Agr., Ottawa, Canada.

Braude, I. D. FORESTRY AND AGRICULTURAL MEASURES TO CONTROL SOIL EROSION IN THE EUROPEAN USSR. Soviet Soil Sci. 6: 670-675. June 1959.

Forestry and agricultural measures to control soil erosion and to protect areas from silting consist of planting different species of trees, sodding, and the building of structures to stabilize soils and soil materials and to regulate and stop surface runoff. Forest plantings on slopes and on the steppe are of great importance for wind protection and moisture. On slopes protected by 5 to 7 rows of trees, wind velocity is decreased an average of 40-50 percent, evaporation by 20-25 percent, and snow contents are increased 30-35 percent; depending on the extent of forest planting, runoff is reduced 25-50 percent or more.

Various recommended soil erosion measures used in Russia are given and described.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Rose, C. W. RAINFALL AND SOIL STRUCTURE. Soil Sci. 91: 49-54. 1961.

Both soil type and the size of structural aggregates were shown to have a very great effect on the detachment of soil caused by rainfall. A comparison of the detachment characteristics of soil with those of sand was used to investigate the variation of rainfall-caused aggregate breakdown with rainfall rate and initial aggregate size. Some results of using splash detachment under artificial rainfall as a technique for assessing natural changes in the structural condition of soils are given.

Makerere College, Uganda, Africa.

Dortignac, E. J., and Love, L. D. RELATION OF PLANT COVER TO INFILTRATION AND EROSION IN PONDEROSA PINE FORESTS OF COLORADO. Trans. ASAE 3(1): 58-60. 1960.

Infiltration and erosion rates of vegetation-soil conditions in the Ponderosa pine forests of Colorado were measured with the Rocky Mountain infiltrometer, a rainfall-simulator. Infiltration rates varied with cover type, soil porosity, and above-ground organic materials. Erosion varied with cover type, soil origin, and quantity of exposed or bare soil. Recovery in infiltration rate after 14 years' protection from cattle grazing was most pronounced in the grassland type. The increased infiltration was attributed to the improved large non-capillary porosity of the surface soil and to the accumulation of litter (dead organic matter). Infiltration and erosion measured with the infiltrometer compared favorably with the values computed from natural rain falling on surface runoff plots. Criteria are proposed for determining satisfactory infiltration rates and acceptable quantities of erosion.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Albuquerque, N. Mex.

Knisel, W. G., Jr., Cox, M. B., and Tucker, B. B. EFFECT OF LAND TREATMENT ON RUNOFF AT CHEROKEE, OKLAHOMA. Okla. Agr. Expt. Sta. B. B-583, 22 pp. 1961.

Analyses of variance and Duncan's multiple range test for testing the statistical significance of tillage treatment mean comparisons were made for 9 years on 9 small watersheds at the Wheatland Conservation Experiment Station near Cherokee, Okla. Tillage treatments included wheatland disking, basin listing, and stubble mulching. The data tested included rainfall, runoff, retention, wheat yields, and peak rates of runoff. The same analyses were made for rainfall, runoff, retention, and wheat yields for five years of uniform tillage. No fertilizer was used on the watersheds during either period. Precipitation normalcy tests were made for the treatment period.

The following conclusions were formulated: (1) The precipitation for the 9-year-treatment period was near normal; (2) there were no significant differences between the watersheds when treated uniformly; (3) mean crop-year runoff was significantly higher for the wheatland disc treatment than for basin listing or stubble mulch treatment, and significantly higher for stubble mulch than for the basin listing treatment; (4) mean crop-year retention (rainfall minus runoff) under basin listing was significantly higher than for wheatland disking or stubble mulch treatment, and for stubble mulch treatment was significantly greater than for wheatland disc treatment; (5) annual peak rates of runoff from basin listing were significantly lower than from wheatland disking or stubble mulch treatment; and (6) wheat yields from wheatland disking and basin listing were significantly greater than from stubble mulch treatment.

SWCRD, ARS, USDA, and Agr. Expt. Sta., Okla. State U., Stillwater, Okla.

Moldenhauer, W. C., and Wischmeier, W. H. SOIL AND WATER LOSSES AND INFILTRATION RATES ON IDA SILT LOAM AS INFLUENCED BY CROPPING SYSTEMS, TILLAGE PRACTICES AND RAINFALL CHARACTERISTICS. Soil Sci. Soc. Amer. Proc. 24: 409-413. 1960.

Soil and water losses from a coarse loess soil in western Iowa have been measured since 1948 on a series of 10.5- by 72.6-foot plots on 12 percent land slope. In a 2-year rotation of corn-oats with sweet clover catch-crop, corn planted up-and-down slope averaged about 25 tons of soil loss per acre per year over the period 1948 through 1957. Contouring reduced the annual loss to 10 tons per acre, and listing on the contour reduced it to 5 tons per acre. Average annual soil loss from corn contour listed in a corn-oats-meadow-meadow rotation was 1 ton per acre. Effectiveness of contour surface planting decreased as storm erosivity increased and for the most erosive storm soil loss exceeded that from up-and-down-hill planting. Prior to the final cultivation, effectiveness of contour listing did not decrease as storm erosivity increased. The effect of cultivation practices on aggregate stability and infiltration rate is discussed.

SWCRD, ARS, USDA, Ames, Iowa.

Smith, R. M., and Henderson, R. C. IN THE BLACKLANDS--SURFACE RESIDUES REDUCE EROSION. Soil and Water (Assoc. Tex. SCD) 10(9): 8. 1960.

Eight years of results with annual rainfall that varied from 13.8 inches in 1954 to 47.4 inches in 1957 indicate that on slopes of 2 to 3 percent, surface residues left by sub-surface or by trash-mulch plowing can be expected to reduce soil erosion 50 percent or more in conservation cropping systems compared to continuous row cropping.



In 1952, a study was started on field-scale plots with trash-mulch and sub-surface sweep plowing with three cropping systems in order to find out the effects of the different systems when residues were left on the surface. The first system was continuous corn; the second was one year of corn following one year of oats with sweet clover; and the third was one year of corn following two years of fescue grass with sweet clover.

Six years of run-off and erosion in the three systems averaged as follows:

		Runoff - Inches			Soil Loss - Tons/Acre		
		Contin-	Corn	Corn	Contin-	6.07	Corn
		uous	after	after	uous	Corn	after
		corn	oats &	2 yrs.	corn	after	2 yrs.
6 Yr. Av.	Rainfall		clover	grass &		oats &	grass &
	inches			clover		clover	clover
1953 thru							
1958	30.5	2.32	1.73	1.69	6.07	2.87	1.78

Over the 6-year period, the average soil loss from corn following oats and sweet clover was 47 percent of the loss from continuous corn, and following grass the loss was 29 percent of that from continuous corn. Erosion from corn in the systems with oats or grass was less than that from continuous corn during each of the 6 years of record.

In 1959, reduced erosion following sub-surface tillage of grain sorghum was obtained from the near-record rain of 8.4 inches on Oct. 4. Two of the run-off erosion plots were in continuous grain sorghum, which had been substituted for corn in the spring of 1959. These plots were sub-surface plowed in early September after the grain was harvested. At about the same time, the four plots of grain sorghum in rotations were disked one way in preparation for drilling to oats and to grass. Then, on Oct. 4, the heavy rain occurred, with acre losses as follows: Continuous sorghum--2.5 inches of run-off and 0.9 tons of soil; grain sorghum which was one-way disked for oats--3.5 inches of run-off and 4.7 tons of soil; and grain sorghum which was one-way disked for grass--3.0 inches of run-off and 2.7 tons of soil.

The effectiveness of the trash mulch lots of grain sorghum was influenced by the above normal rainfall during September, which kept part of the stubble alive and germinated the wasted grain on the surface. With one-way disking, the stubble was largely turned under and killed and the surface was relatively bare, because volunteer grain had not emerged.

SWCRD, ARS, USDA, Blackland Conserv. Expt. Sta., Temple, Tex.

### Strip Cropping

Greb, B. W., and Black, A. L. NEW STRIP CROPPING PATTERN SAVES MOISTURE FOR DRYLAND. Crops and Soils 13(5): 23. 1961.

New strip cropping designs are being used at the USDA Central Great Plains Field Station at Akron, Colo., in an attempt to put drifting snow to work in the field rather than having it blown into fence rows and ditches.

Termed snow trapping, the new designs are another approach to moisture conservation by use of strip cropping. Snow spreading is growing a natural snow fence of parallel double rows of sorghum at intervals across a field of summer fallow wheat land. Intervals can vary from 50 to 150 feet to fit the farmer's equipment.

Sorghum is drilled in June at regular seeding rates and winter wheat is seeded at the normal time in early fall. Soil moisture used by the sorghum may stunt the first row or two of wheat next to the sorghum, but this may be offset by later snow deposit.

Snow trapping involves 8- to 12-row strips of sorghum spaced at 3:1 or 2:1 width ratios with wheat. The sorghum stubble catches snow blowing off wheat. This snow will provide moisture for next year's sorghum crop. A blowing 4-inch snow would deposit the moisture from 10 to 12 inches of snow into the sorghum stubble trap. Snow crystals in the drifts from this wind-driven snow are broken down into a sandlike texture with a higher water content than loose snow.

For large-scale farming, a ratio of 120 feet of wheat or fallow to a 12-row (36 to 42 feet) sorghum strip is suggested according to experience during two winters. The wheat strips are cropped in alternate years.

SWCRD, ARS, USDA, Akron, Colo.

Wilson, T. I. STRIPCROPPING PACIFIC NORTHWEST GRAINLANDS. J. Soil and Water Conserv. 16: 25-27. 1961.

About one-half of the Pacific Northwest's 8 million acres of cultivated land is in grain; the rest lies fallow each year. Wind and water erosion still are taking excessive amounts of soil from these dry-farmed lands. Erosion is caused chiefly by runoff resulting from rainstorms falling on freshly prepared seedbeds or summer fallow, by runoff of excess fall and winter moisture, and by severe windstorms on poorly protected grainlands.

Strip cropping is a practice which gives maximum protection from wind and water erosion on cultivated lands. It is most effective when used with a complete conservation program of stubble mulch, rough tillage, contouring, grass-legume rotations, and effective water disposal practices. Four types of strip cropping are used:

1. Wind Strip cropping - Wind strips are uniform in width, usually straight, and laid out as nearly as possible at right angles to prevailing winds. Widths of strips varies with soil types, cropping and tillage system, and anticipated wind velocities. Minimum width usually is not less than 75 feet, and maximum width should not exceed 240 feet.
2. Contour Strip cropping - Contour strips are at right angles to the natural slope of the land. They are used to control water erosion and also may be effective on sloping land where wind erosion is serious. They are often uneven in width depending upon the uniformity of slope. Maximum strip width in eastern Oregon should not exceed 240 feet on slopes under 12 percent. Width of strips on slopes greater than 12 percent is determined by the formula:

$$\frac{130 \times 100}{\text{percent of slope}}$$

3. Field Strip cropping - Field strip cropping is similar to wind strip cropping except that uniform strips are placed at right angles to the general slope of the land rather than at right angles to the wind. They do not curve to conform to the contour in crossing drainageways. This system is useful for general sloping areas where topography is too irregular for practical contour strip cropping. Most of the layouts for water erosion control are combinations of contour strip cropping and field strip cropping. A 20 percent or more slope is avoided for crop production purposes and uneven strips are held to a minimum.
4. Buffer Strip cropping - Buffer strips of grass or grass-legume mixtures are laid out between strips of crops in regular rotation. They may be wide or narrow and may be of even or variable widths. They may be

placed only on the steep, badly eroded parts of a slope or at more or less regular intervals on the slope. The buffer strips are used to give more protection from erosion than is afforded by a solid planting of grain or intertilled crops. They are particularly useful on grain-fallow ranches producing livestock. They allow full use of stubble pasture during the years the field is in crop and provide considerable protection when the fields are in fallow. They may be used to take up uneven areas between contour strips making the strips in production easier to farm.

Measurements of soil losses by the Soil Conservation Service show strip cropping is 50 to 90 percent effective in preventing soil losses.

Strip cropping, in combination with other needed conservation practices, remains one of the most effective soil and water conservation systems.

SCS, USDA, Heppner, Oreg.

## Terracing

Smith, R. M., and Henderson, R. C. SOME INTERPRETATIONS OF RUNOFF AND EROSION FROM TERRACES ON BLACKLAND SOIL. U. S. Dept. Agr., Agr. Res. Serv. ARS 41-42, 15 pp. 1961.

Results indicate that with clean or conventional tillage of corn or cotton the quantity of soil discharged from terrace channel outlets is related within reasonable limits to quantities of runoff. There is a highly significant correlation between average annual rainfall and average annual runoff. These relationships appear close enough for use in estimating the amount of soil removal from cultivated fields or the contribution of the fields to sediment loads of streams.

With small grain and/or clover on all or on only part of the land between terraces, average soil and water losses from terrace channels are lower than with corn or cotton. This indicates that cropping practices are a major factor influencing the functioning of terraces.

Variations in terrace length and channel grade within rather wide limits may not result in serious erosion losses from a field where a conservation cropping system is used, or where the terrace spacing is close enough to prevent excessive concentrations of water. Under many condition, a critical problem with terraces is interterrace erosion into the channel in excess of that discharged at the outlets. Uphill plowing or other mechanical method of moving soil up the slope out of channels and onto the interterrace area appears to need increased emphasis, if erosion control by means of terraces is to be fully effective.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Critical Areas

Risk, J. B., and Chaster, G. D. FISH SOLUBLES HALT EROSION. Crops and Soils 13(8): 10-11. 1961.

Fish solubles, a standard byproduct of the fish processing industry, has been found to be an excellent material for stabilizing and establishing vegetation on sterile soil slopes.

The most satisfactory and permanent method of halting such costly bank erosion is by establishing vegetation on erodible slopes, but two factors often prevent stand establishment. In addition to the normally sterile soil, seed, once applied, frequently is carried away by wind and water. Even if seeds germinate, young roots often are destroyed by shifting slopes.

The application of a mixture of seed and fish solubles to such slopes, followed by a lime slurry, stabilizes the surface against wind and water erosion



until a healthy vegetative cover can be established. At the same time, the fish solubles supplies necessary organic materials and minerals for growth. Typical material contains 5.5 percent nitrogen, 2.6 percent  $P_2O_5$ , 2.2 percent  $K_2O$ , and has a pH of 4.1.

The process consists of two steps. First, a mixture of seed in a dilute lime slurry. This is followed by a light spraying of dilute lime slurry. A reaction occurs between the lime and the fish solubles, resulting in a tough, water-resistant crust forming on the soil.

Comparative tests using the fish solubles process, standard Ferti-Seeding procedures, and the Ferti-Seeding method without mulch, were made on fresh highway cuts near Vancouver. The Ferti-Seeding procedure consisted of spraying onto the surface a watery mixture of seed and inorganic fertilizer followed by a straw-asphalt mulching.

The use of straw mulch gave a dense cover, but fish solubles produced the most vigorous growth. Four months after seeding, and following an extended dry period, grass on plots treated with fish solubles was still green and beginning to set seed.

The other plots had dried out and showed little green except in the previously existing erosion gullies. On plots treated with seed and fertilizer without mulch, there was definite new erosion evidence.

In the weeks immediately following treatment, the conventional seed-fertilizer plus asphalt-straw mulch application gave the fastest initial germination and growth. The simple seed-fertilizer without mulch treatment ranked second. Fish solubles ranked third and produced the slowest germination. But this treatment nevertheless afforded--from the outset--complete protection against erosion. This was possible owing to the firm crust that is formed on the soil surface.

This crust did not disintegrate when wet and 3 months after being applied there was still clear evidence of its continuing presence and effectiveness in preventing wind and water erosion. In some areas the seed had not germinated 15 weeks after seeding, but seed appeared to be viable.

The experiments showed that a cover of vegetation can be established under adverse soil and weather conditions, and that the process using fish solubles gave excellent results.

Estimates of comparative costs show a distinct advantage for the fish solubles process, particularly where transportation is an important item.

British Columbia Res. Council, U. British Columbia, Vancouver, British Columbia, Canada.

## SOIL MANAGEMENT

### Cropping Practices

Agronomy Panel of Seven. GROWING CONTINUOUS CORN. Crops and Soils 13(6): 9-12. 1961.

Continuous cropping has taken on new proportions in the minds of many an American farmer. But the major question demanding an answer is: Will continuous cropping, which adequately maintains soil productivity, now be possible in any area?

The importance and potential of this question increase each year as more farmers adopt modern soil management practices such as correct grade, rate, and placement of fertilizer, minimum tillage, and chemical control of weeds, insects, and diseases.

These factors, along with favorable cost-price relationships, desire for more specialization and seasonal work, improved machinery, need for maximum use of high-priced land, and favorably priced, easy-to-handle commercial fertilizers, are causing farmers to take a closer look at continuous cropping.

The following papers report on growing continuous corn in selected states.

1. Van Doren, D. M., Jr., and Triplett, G. B., Jr. OHIO. Ohio Agr. Expt. Sta., Wooster, Ohio.
2. Wengel, R. W. CONNECTICUT. U. Conn., Storrs, Conn.
3. Baird, J. V., and Aldrich, S. R. ILLINOIS. U. Ill., Urbana, Ill.
4. Beatty, M. T. WISCONSIN. U. Wisc., Madison, Wisc.
5. Shrader, W. D. IOWA. Iowa State U., Ames, Iowa.

Anderson, L. E. JOHNSONGRASS IN KANSAS. Kans. Agr. Expt. Sta. C.380, 12 pp. 1961.

An important forage in most sections of the South, johnsongrass is second only to field bindweed as a weed menace in Kansas. Originally introduced in South Carolina, it has spread north to Michigan, west to California, and now is a major weed problem in many states. Johnsongrass now is literally choking out crops in fertile bottomlands and irrigated areas throughout Kansas. It has been declared a noxious weed in 90 Kansas counties under the State weed law. Numerous states have legislation regulating movement of johnsongrass hay and seed, but it continues to spread to new areas, showing little respect for natural or legal boundaries.

Johnsongrass is highly controversial as a prized forage plant for hay or pasture, or as a noxious weed difficult to control.

As a forage, johnsongrass yields well, is palatable to livestock, and is highly nutritious. Under favorable conditions it yields from 3 to 5 tons of hay per acre under dryland farming and up to 15 tons when irrigated. When properly harvested and cured, it makes excellent hay that compares well with timothy or sudangrass in feeding value. Although relished by all classes of livestock, it is not considered a good permanent pasture grass because heavy grazing weakens the stand and permits inferior grasses and weeds to become established.

Johnsongrass cannot be used conveniently in a crop rotation because it persists by rhizomes and seeds and interferes with other crops.

A johnsongrass control program should: (1) Kill or weaken established plants and their underground rhizome systems; (2) control seedlings originating from seed already in the soil; and (3) prevent production of seed and its spread to new areas.

Control programs may vary from only suppressing johnsongrass to complete eradication. By suppressing it, a farmer "lives with the weed" and grows crops in the infested areas. It is possible and highly desirable to kill johnsongrass and prevent seed production with chemicals in limited infestations. The area treated by chemicals should be watched carefully for several years and re-treated as necessary. The critical time to kill johnsongrass is while the weed is becoming established. At this early stage a farmer should aim for complete eradication regardless of cost.

Johnsongrass areas can be so large that using chemicals to kill it would cost too much, then the objective should be to suppress it so certain crops can be grown.

Growing early maturing crops, plowing immediately after harvest, then cultivating as needed are common ways to control johnsongrass in fields. Winter wheat fits well into this system. Intensive cultivation between plowing and sowing time for wheat will greatly reduce johnsongrass stands and prevent seed production. Other small grain crops that are harvested early can also be grown successfully in fields infested with johnsongrass. Once established, alfalfa will compete well with johnsongrass for a limited time but it gradually weakens. Repeated mowing of an alfalfa-johnsongrass mixture will prevent johnsongrass from producing seed. Late-maturing row crops such as corn, sorghums, and soybeans should not be grown in johnsongrass infested areas.

For large infested areas that cannot be cultivated or sprayed, intensive grazing probably is the best control. Although continuous grazing may not completely eradicate johnsongrass, it prevents or reduces seed production. Repeated mowing has an effect similar to intensive grazing. The johnsongrass should never be allowed to approach maturity, and under no circumstances should it produce seed.

For small inaccessible infested areas in river bottoms, wastelands, irrigation ditches, and roadsides, chemicals are an effective control. The chemicals approved for use under the Kansas Noxious Weed Law are discussed.

Agr. Expt. Sta., Kans. State U. Agr. and Applied Sci., Manhattan, Kans.

Brender, E. V. CONTROL OF HONEYSUCKLE AND KUDZU. Southeastern Forest Expt. Sta., Sta. Paper 120, 9 pp. 1961.

Japanese honeysuckle and kudzu, both introduced from Asia, have spread throughout the South through natural and artificial means until today they constitute major deterrents to regeneration of major forest species. Although they have some economic value for grazing, the problem is one of confining them to specified areas.

Honeysuckle thrives on fertile, nitrogen-rich soil; it spreads vegetatively by layering and sexually by prolific production of seed with a high viability under Piedmont conditions. Kudzu spreads by stolons and rhizomes and, being a nitrogen-fixer, once established it can grow on poorer sites than honeysuckle.

Control studies during the past 9 years include tests of grazing, burning, harrowing, mulching, the use of herbicides, and combination methods. Summer grazing reduces the vigor of both species, but is greater for kudzu.

Controlled burning or harrowing are recommended as pre- and post-treatments to herbicidal spraying of either species.

The most effective herbicide treatment for honeysuckle control consists of spraying with a mixture of 8 pounds Amitrol-T in 100 gallons of water, plus 4 ounces of a wetting agent, applied with a power sprayer at rates of 200 gallons per acre when the honeysuckle puts on new growth in the spring. This herbicide should not be used in food-crop producing or forage areas.

The most effective herbicide treatment for control of kudzu consists of spraying with a mist blower, using a mixture of 1 gallon (2 pounds acid equivalent) oil stable 2, 4, 5-T in 4 gallons of nonphytotoxic oil, applied at rates of 5 gallons per acre when kudzu foliage is full grown.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Trevett, M. F., and Murphy, H. J. A GUIDE FOR THE USE OF CHEMICAL WEED KILLERS IN 1961. Maine Agr. Expt. Sta. Misc. P. 645, 35 pp. 1961.

The recommended chemical weed control methods for vegetables, small fruits, field crops, and turf are given for Maine.

Maine Agr. Expt. Sta. and Maine Ext. Serv., Orono, Maine.



Juska, F. V. CHOOSING A GRASS FOR YOUR LAWN. Plant Food Review 7(2): 8-11. 1961.

With a little know-how and the application of several basic management practices, the average homeowner can materially improve a poor lawn and maintain a good one year after year.

Temperature and moisture are the controlling factors in the adaptation of grasses for turf. The United States can be divided into five turfgrass regions based on climatic conditions. They represent the average limits of the adaptation of the species of grasses involved. Some grasses can be grown beyond the average limits of adaptation because their tolerance to temperature and moisture extremes is greater than those of the average species.

Some causes of poor lawns are: (1) Improper fertilization; (2) improper mowing; (3) unadapted species; (4) poor watering practices; (5) too much traffic; (6) poorly drained or droughty soils; (7) too high or too low soil pH; and (8) seeding at the wrong time for particular species.

Culture and care practices for a good lawn in each of the five regions are given.

CRD, ARS, USDA, Beltsville, Md.

### Crop Residue Management

Peterson, A. E., and Engelbert, L. E. GROWING CORN IN WISCONSIN WITHOUT PLOWING. Wisc. Acad. Sci., Arts and Letters 48: 135-140. 1959.

A 4-year study was made to determine if corn can be grown successfully in Wisconsin without previous plowing. Comparisons were made of corn planted with the conventional method and corn planted with a special mulch planter. With average weather conditions and use of an adapted hybrid, excellent yields were obtained for both methods.

The results indicate that to mulch plant successfully one must: (1) Provide adequate plant food for both corn and weeds; (2) follow normal good corn cultural practices; (3) make sure that a tractor with the necessary power (3 plow or more) is available; and (4) carefully adjust the depth of the sweeps (this is especially important on sloping land). Soil and water losses from mulch planted fields having slopes up to 10 percent were negligible even with intense rains of 2 inches per hour, whereas, with conventional planting, losses of 10 tons of soil and 1.75 inches of water per acre occurred.

Although the difficulties encountered in satisfactorily planting corn with the mulch planter make it relatively impractical on the average Wisconsin farm, this study clearly demonstrated the potentials of this soil tillage methods for growing corn.

U. Wisc., Madison, Wisc.

Larson, W. E., and Beale, O. W. USING CROP RESIDUES ON SOILS OF THE HUMID AREA. U.S. Dept. Agr. Farm. B. 2155, 14 pp. 1961.

Many crops grown in the Eastern United States produce considerable plant materials in addition to the harvested or grazed parts. These plant materials are usually left in the field until the planting of the next crop, when they are returned to the soil through various tillage operations for seedbed preparation. If these plant residues are used properly, they contribute immensely to the maintenance and increase of the ever-dwindling soil organic matter and to the reduction of runoff and soil erosion.

Nutrient content per ton of unharvested or ungrazed parts of plants above the ground usually returned to the soil<sup>1</sup>

Crop	Nitrogen (N)	Phosphorus (P <sub>2</sub> O <sub>5</sub> )	Potash (K <sub>2</sub> O)
	<u>Pounds</u>	<u>Pounds</u>	<u>Pounds</u>
Barley-----	12	5	29
Oat-----	12	4	30
Rye-----	10	6	17
Wheat-----	14	3	23
Corn-----	18	8	20
Cotton-----	22	7	35
Soybean-----	12	9	25
Grasses-----	40	4	43
Alfalfa-----	48	11	45
Red clover-----	38	9	35
Sweetclover-----	36	9	33
Cowpea-----	62	12	45
Vetch-----	62	14	46
Ladino clover-----	60	13	60
Lespedeza-----	42	10	20
Fescuegrass-Ladino clover-----	61	17	62
Ryegrass-crimson clover-----	60	13	61

<sup>1</sup> Soil, fertility level, weather conditions, stage of maturity of the plant, and other factors can influence the nutrient content of these crops. Values shown reflect the averages for plants at the time of usual harvest. Generally, immature plants contain higher percentages of nutrients than mature plants.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Tillage

Bowers, W., and Bateman, H. P. RESEARCH STUDIES OF MINIMUM TILLAGE. Trans. ASAE 3 (2): 1-3, 12. 1960.

Obtaining a good population was the key to successful minimum-tillage planting. Any method that provided a good seedbed in the row and promoted germination produced yields equal to those of conventional planting. In the tests, minimum tillage yields ran high in proportion to population. Average population for the 50 comparisons was 95 percent of conventional, and yields were slightly over 101 percent.

Conventional tillage provided excellent germination and early growth, but compaction from excessive tillage reduced aeration and water intake for the growth stage immediately prior to tasseling. This compaction effect was most pronounced on clay soils, where less compaction from minimum-tillage sometimes gave a yield advantage.

Excessive tillage affected silty soils or soils with excellent tilth less than plastic soils with poor tilth. Most of the yield advantage for minimum-tillage came on soils that were troublesome from the standpoint of tilth.

Moisture at planting time was important in a minimum-tillage operation, particularly on sod fields that were dried out with lack of rain. In a minimum-tillage system, these fields should be planted first. There was considerably less risk in planting in moist soil than dry soil. Moisture helped in shattering the furrow slice when plowing, and it aided germination.

Successful minimum-tillage required a good job of plowing with correct use of plow accessories to help bury trash and level the furrow.

Minimum-tillage reduced the problem of controlling weeds. Most of the minimum-tillage plots in these comparisons had only one cultivation.

The first year for minimum-tillage in a given field was the hardest. Tilth usually improved by the second year and made it easier to establish a good seed-bed.

The farmer must determine which minimum-tillage technique works best for his soil conditions. It may be best to approach minimum-tillage slowly, using something like a plow, till, then plant operation for the first year or two.

U. Ill., Urbana, Ill.

Rao, A. A. S., Hay, R. C., and Bateman, H. P. EFFECT OF MINIMUM TILLAGE ON PHYSICAL PROPERTIES OF SOILS AND CROP RESPONSE.

Trans. ASAE 3(2): 8-10. 1960.

Minimum tillage was compared with conventional tillage. Minimum tillage consisted of plowing and the planting in the tracks of a special press wheel, with no intermediate tillage. All the treatments were made on first-year corn ground, and a heavy growth of alfalfa was plowed under. For conventional tillage, the additional operations were four tandem-disking operations. The soil types were Drummer cl and Brenton sil. The planting date (June 4) was late due to frequent rains in May.

The authors summarized their work as follows:

1. Minimum tillage resulted in the following improved soil physical conditions: (1) Higher rate of infiltration; (2) less soil resistance to penetration; (3) lower bulk density; and (4) less soil compaction due to tractor and implement traffic.
2. These soil physical properties for minimum tillage affected the crop in the following ways: (1) Less weed population; (2) less plant mortality due to cultivation; (3) more root growth; (4) taller corn; (5) less stalk population; (6) fewer lodged stalks at harvest; (7) less corn loss in harvest; and (8) same yield as conventional tillage at the existing stalk population.
3. The effect of minimum tillage on the physical condition of the soil was more evident by the measurement of infiltration rate and soil resistance to penetration than by bulk density, soil moisture, and clod size measurements.
4. Minimum tillage appeared to be better suited to coarse and medium-textured soil types than to the more plastic soils with a high clay content.
5. Minimum tillage tended to produce an uneven rate of planting of corn, and uneven germination, especially on soils with a higher clay content.
6. Minimum tillage resulted in a saving of machine time.
7. The survey indicated that farmers of Illinois are accepting minimum-tillage methods.

Jr. Author, U. Ill., Urbana, Ill.

De Roo, H. C. DEEP TILLAGE AND ROOT GROWTH: A STUDY OF TOBACCO GROWING IN SANDY LOAM SOIL. Conn. Agr. Expt. Sta. B. 644, 48 pp. 1961.

The coarse to medium-textured soils of the Connecticut Valley are intensively used for the production of row crops. In these weakly structured soils normal tillage induces hardpans just below the recent plow layer, and these plow pans inhibit root penetration. Studies were made in the Merrimac sl, typical soil



of the well-drained and well-aerated tobacco soils in the Valley. A survey of these soils had shown that most crops were shallow-rooted, especially tobacco.

Small field-plots were used to learn which root habits were inherent and which were controlled by environment. These plots were established and managed by hand. The principal conclusions were:

1. Tobacco can be deeply rooted; breaking the plow pan permitted deep profuse rooting. Deep rooting was evident in all deeply loosened soil, whether topsoil or subsoil. Neither the penetration nor the distribution of the roots was greatly influenced by fertility, either in the form of topsoil or of added fertilizers. However, the weight of roots below the 6-inch depth of cultivation was markedly increased by the fertility from a deep placement of additional fertilizer or from a doubling of the depth of topsoil.
2. Expanded and increased root growth produced heavier shoots: the higher the root weights in the 6- to 24-inch zone, the higher the leaf yields. Adding fertility in the form of topsoil was less effective than adding fertilizer, deeply placed.
3. None of the treatments or profile modifications had any large and consistent effect on the commercial quality of the cured tobacco leaves.
4. The nutritional fertility of the soil was reflected in the nitrate nitrogen concentration of the leaves, which was closely correlated with the amounts of roots. In the leaves, the quantity of nicotine was clearly affected by soil looseness and fertility and significantly correlated with the root yields. The concentration of nicotine was unaffected.
5. A micronutrient native to the subsoil was not oversupplied nor was the chemical composition or quality of the leaves affected through deep tillage unless the soil profile was drastically changed. The iron concentrations of leaves increased significantly only when the plants were grown in pure subsoil profiles, and even then the commercial quality of the cured leaves was not affected.

On the machine-tilled plots, the following practices were explored for 3 years: (1) Subsoiling with and without deep placement of additional fertilizer; (2) chiseling from the furrow bottom with and without deep placement of additional fertilizer or chiseling from the furrow bottom with half the surface fertilizer plowed down; and (3) deep plowing.

The following conclusions and practical considerations are based on the more important findings.

1. Springtime deep tillage combined with deep fertilization increased the leaf yields consistently, although not always significantly. Most successful was spring plowing plus chiseling from the furrow bottom with deep placement of additional fertilizer. Also beneficial was subbase plowing and deeper incorporation of half the broadcasted surface fertilizer.
2. Falltime deep tillage was less beneficial. Without spring plowing, dry soil made intensified harrowing necessary for the preparation of a proper plantbed. In most years, fertilizer placed in the fall was leached by winter and early spring rains.
3. Effect of deep tillage and plowing is transitory because recompaction of this sandy loam soil is easy. Rain and resettling overwinter recompact the soil, but the most severe recompaction is due to secondary tillage, which forms a disk pan within the plow layer. Green manuring with winter cover helped to minimize this recompaction and might improve the tilth of the soil.
4. Roots are restricted by bulk densities of the soil above about 1.52, while fertilizer affects amount of roots.
5. Deep tillage with machinery seldom produced the uniformly profuse rooting throughout the tilled soil which was observed following deep tillage by hand. Recompaction of the soil just below the depth of secondary

tillage limited the feeding area within the topsoil and was probably responsible for the smallness of the yield increases from machine tillage, which, over the 3-year period, did not exceed 11 percent.

6. Deep plowing to a great depth, 16 inches, turns up much subsoil and demands great additions of fertilizer, phosphate, and lime.
7. Deep plowing can turn up fresh, uninfested soil and this "vertical rotation" can control brown root rot as effectively as fumigation.
8. Intermediately deep tillage, 12 to 15 inches, was beneficial, because recompaction destroys the established tilth, and because costs were less than of deep tillage. Plowing at different depths each year can slow down the formation of a plow pan. Limiting all secondary tillage and cultivation to a minimum causes less soil compaction, requires less labor, and costs less; it is a prerequisite for any successful attempt to deepen the effective rooting depth.

Conn. Agr. Expt. Sta., New Haven, Conn.

Saveson, I. L., Lund, Z. F., and Sloane, L. W. DEEP-TILLAGE INVESTIGATIONS ON COMPACTED SOIL IN THE COTTON AREA OF LOUISIANA. U.S. Dept. Agr., Agr. Res. Serv. ARS 41-41, 21 pp. 1961.

The deep-tillage investigations on Commerce sil containing restricting layers ("hot spots") indicate that deep tillage is effective in years of moisture stress. The soil moisture data indicated that the compacted areas interfered with the recharge of deep soil moisture during the winter. The Edged and Lifted 1 Level treatments dispersed the compaction and facilitated (statistically significant) the deep soil moisture recharge by increasing infiltration of rainwater in the winter months. In this capacity, the Mixed treatment was not effective.

Yield data indicated that both the Edged and Lifted 1 Level treatments substantially increased yields when moisture deficiency was a problem (1954 and 1956). Increases in yields ranged from 835 to 1,783 pounds per acre for the Lifted 1 Level treatment and from 592 to 1,106 for the Edged. Lifting was more effective the first crop year following treatment than later. Edging was more effective the second crop year following treatment than the first year following. There was no measurable significant change in soil physical properties between the treated and untreated plots. Other factors which may affect water intake, such as soil particle arrangement, were not measured.

The Louisiana cotton area can expect periods of moisture stress June through September in 5 of 10 years. In these years of moisture stress, deep tillage will pay dividends, since yields are increased by one-half bale or more per acre and current deep-tillage costs run from \$7 to \$10 per acre on a contract basis. A profit of at least \$50 per acre can be expected from deep-tillage 5 out of 10 years.

Maps and graphs.

ARS, USDA, Inform. Div., Washington 25, D. C.

Johnson, W. H., and Taylor, G. S. TILLAGE TREATMENT FOR CORN ON CLAY SOILS. Trans. ASAE 3(2): 4-7. 1960.

An experiment was carried out on Holtville sic soil in an effort to evaluate certain minimum-tillage treatments.

Crop response was improved with minimum seedbed preparations; however, obtaining consistent and adequate stands was a problem in these heavy soils.

The following evaluation is made of some general practices: (1) Plowing 6 to 7 in. deep was beneficial. (2) Fall or winter plowing which permits frost action (at least one hard freeze) is an effective means of accomplishing a granular seedbed in fine-textured soils. The practice can best be recommended where

erosion is of no concern. (3) In spring-plowed land, it is an advantage to "break down" the furrow slice at the time of plowing with plow-pulled tillers in an effort to prevent rapid loss of moisture which makes surface granules extremely stable. (4) Any attempt to till or plow the soil above field capacity will result in damage to stand and crop response. (5) Extra tillage operations are of little or no benefit. Extra operations with a disk harrow resulted in placing fine aggregates below the seed level and brought large granules to the surface. And (6) compactive effort from a soil packer or seed press wheel slightly enhanced stands and crop response in spring plowed treatments but damaged fall-plowed treatments. The practical significance of such pressure treatments is questionable based on the results obtained.

A seedbed which was characterized, at the 1 to 3-in. level, by 30 percent of the soil passing a 0.1-inch sieve resulted in the best emergence. Stands seemed to be more nearly correlated to the proportion of soil less than 0.1 inch, than to soil moisture at the time of planting.

Effective minimum-tillage treatments were: Fall plowing with essentially no secondary spring treatment; the modified till planter; and a conventionally prepared minimum seedbed. Ridge planting and field cultivation were also effective; however, they cannot be classified as low effort treatments.

Plow-plant and tractor-wheel-plant treatments were fairly satisfactory from the standpoint of crop response, but low in stand.

The treatments involving the till planter, rotary tiller, and disk (substituted for plowing) were less desirable from the standpoint of yield, stand, or practicality and cost than plowing followed by minimum fitting.

Ohio Agr. Expt. Sta., Ohio State U., Wooster, Ohio.

Lein, H. SOIL PREPARATION: DON'T OVERDO A GOOD THING. Western Crops & Farm Mangt. 10(1): 15-17. 1961.

Modern tillage equipment is one of the best investments a grower can make; but overused, or used for the wrong purpose, it can do irreparable damage to soil particles.

If a tillage operation does not accomplish one or more of the following or if it inhibits any of these purposes, it is wasteful and probably harmful: (1) Control erosion; (2) eliminate weeds; (3) prepare seedbeds; (4) incorporate crop residues; (5) obtain more favorable water intake rates; and (6) develop air movement through the soil.

A furrow slice now weighs from 100 to 300 tons more per acre than it once did. This increase of 10 to 30 percent requires more power to plow and causes water penetration problems.

No address given.

Anderson, D. T. SURFACE TRASH CONSERVATION WITH TILLAGE MACHINES. Canad. J. Soil Sci. 41: 99-114. 1961.

The conservation or reduction of surface trash resulting from the use of some common tillage implements for cultivating fallow land was studied in a series of 32 field trials. The weight of the surface trash cover was determined before the first tillage stroke was conducted and again after each operation. The data for each trial were collected over a fallow period of about 2 months and were expressed as a percentage of the original weight of the spring wheat stubble cover.

The wide-blade cultivator reduced the original surface cover by generalized values of 15, 10, and 4 percent or less after the first, second, and third and subsequent operations, respectively. Results with the rod weeder, when used for secondary tillage, were similar to those given above for the wide-blade cultivator. These machines, if used for two operations on fields initially tilled



with the one-way disk, lifted an average of 14 and 11 percent of the original cover back to the surface.

The heavy-duty cultivator reduced the original surface cover by average values of 30 to 50 percent during primary tillage and 5 to 20 percent during the second operation. These results were strongly influenced by factors involved in machine operation.

Generally, the one-way disk and the one-way flexible-disk-harrow reduced surface cover by 50 percent during each operation at a depth of 3 to 4 inches. Trash reduction during primary tillage with the one-way disk increased with an increased depth of tillage and decreased with increased weights of surface cover. The tandem disk provided about the same results as the other disk machines.

The use of one or more machines in a tillage sequence provides a means of regulating surface trash on a quantitative basis.

Canada Dept. Agr. Res. Sta., Lethbridge, Alberta, Canada.

Mathieu, A. L. CHISEL ATTACHMENTS FOR THE BLADE CULTIVATOR.  
Canad. J. Soil Sci. 41: 81-85. 1961.

Chisel attachments for the Noble blade cultivator are described. The attachments on the blade holder are designed to chisel a hardpan subsoil to a fixed depth below the blade cut. They differ from the present commercial types of chiseling equipment in that the shanks are attached to a main sub-frame instead of a top-frame. Thus, chiseling with the blade results in a minimum disturbance of the surface mulch and the mulch moving over the blade covers the subsurface vertical grooves made by the chisels. Water infiltration is promoted in the surface soil by the surface mulch and in the subsoil by the grooves. Cultivation with the chisel attachments on the blade does not interfere with the trash mulch necessary for surface erosion control and improves the physical condition of the subsoil.

Res. Council Alberta, Edmonton, Alberta, Canada.

### Fertility Requirements for Conservation Farming

Owens, L. D. NITROGEN MOVEMENT AND TRANSFORMATIONS IN SOILS AS EVALUATED BY A LYSIMETER STUDY UTILIZING ISOTOPIC NITROGEN.  
Soil Sci. Soc. Amer. Proc. 24: 372-376. 1960.

A lysimeter experiment was conducted to determine the fate of N applied to soils several months prior to cropping. Ammonium sulfate, labeled with N-15, was applied to soils in lysimeters at the rate of 120 pounds of N per acre during each winter of the 2 years that the experiment was conducted. Each year, three moisture rates, 12, 18, and 24 inches were established on the soils during the 5 months prior to crop seeding. Total and labeled N were determined in the leachates, crops, and soils at the end of the experiment.

An average of  $33 \pm 6$  percent of the applied N was unaccounted for at the end of 2 years and was assumed to have been denitrified. Denitrification losses were not affected by the moisture treatment imposed. Leaching losses were directly proportional to the amount of water moving through the profile and ranged from 5 to 20 percent from the low to high moisture rates. Losses of fertilizer N by leaching occurred largely at the expense of crop uptake. The amount of fertilizer N remaining in the soils at the end of the experiment was around 38 percent and not affected by moisture treatment.

SWCRD, ARS, USDA, Beltsville, Md.

Kurtz, L. T., Owens, L. D., and Hauck, R. D. INFLUENCE OF MOISTURE ON THE EFFECTIVENESS OF WINTER-APPLIED NITROGEN FERTILIZERS. Soil Sci. Soc. Amer. Proc. 25: 40-43. 1961.

Two field experiments were conducted to compare the effectiveness of 3 forms of N when applied in the winter to a silt loam soil receiving 3 different rates of moisture. Ammonium sulfate, sodium or calcium nitrate, and urea were applied in the winter at the rates of 0, 60, 120, and 240 pounds of N per acre. The moisture rates ranging from 9 to 29 inches were established for the 5 months between fertilizer application and crop seeding. Four forage crops were then grown successively on the plots over a period of 2 years. Yield and nitrogen contents of the crops were determined for each plot.

Nitrogen contents of crops from fertilized and unfertilized plots were, in general, inversely proportional to the amount of moisture applied to the plots during the winter and spring. Crop uptake of N from plots receiving ammonium, urea, and nitrate N was generally similar at lower moisture and N rates. However, uptake was less from nitrate-treated plots than from the corresponding ammonium-treated plots when applications of either N or moisture were increased to high levels. Experimental conditions were probably conducive to nitrogen losses through leaching and denitrification.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Drake, M., and White, J. M. INFLUENCE OF NITROGEN ON UPTAKE OF CALCIUM. Soil Sci. 91: 66-69. 1961.

The yield, percent and total calcium, and percent potassium for oats, tomatoes, and buckwheat tops, grown with and without limestone at 4 levels of nitrogen, were presented in table form.

Tomatoes with a characteristic root C.E.C. of 35 me./100 g. showed a 5-fold-yield response to limestone, and without limestone they made little growth. There was no yield response to nitrogen when limestone was not added. When limestone was added, only the first increment of added nitrogen increased yields. In pots receiving limestone, each nitrogen increment resulted in relatively large increases in total calcium. Nitrogen produced highly significant increases in percent calcium for all except the highest level.

Buckwheat with a characteristic root C.E.C. of 40 me./100 g. showed a yield response both to limestone and to the second level of nitrogen. With each increase in the level of nitrogen fertility when buckwheat was grown with limestone added, the percent and total calcium increased. Although the yield was almost constant (35.8 to 34.1 g.) between the 510- and 680-pound nitrogen treatments, the calcium increased from 0.69 to 0.99 percent, and total calcium from 247 to 338 mg. This indicates that the effect of nitrogen upon calcium uptake was a phenomenon independent of the amount of top growth.

Oats with the lowest characteristic root C.E.C. (22 me./100 g.) of the three test species showed a yield increase and an increase in calcium uptake due to limestone. The yield response to nitrogen was variable and nitrogen was not effective in increasing the percent or the total calcium. With the limestone treatment, the percent potassium of oats was increased with each nitrogen increment.

U. Mass., Mass. Agr. Expt. Sta., Amherst, Mass.

Butler, B. J. TO CUT COSTS, APPLY AMMONIA AS YOU TILL THE SOIL. Ill. Res. 2(4): 15. 1961.

Separate application of ammonia usually costs 2 dollars an acre or more and calls for farm labor when it is sorely needed in other field operations. The extra trip across the field to apply ammonia also increases soil compaction.

Tests in Illinois have shown that very little ammonia is lost if it is properly applied during plowing and disking. The tests were conducted on three soil types and under widely varying conditions of soil moisture and temperature.

The ammonia was applied under the furrow slice of a moldboard plow or behind the rear gangs of wheel-mounted tandem disk harrows. In all tests, the ammonia was released at points almost as deep as the tillage so that a maximum of loose soil was above the escaping fluid. Application rates varied with the speed of tillage but were from 140 to 200 pounds per acre on the basis of 40-inch spacing.

Average losses obtained from more than 50 tests of plow and disk application are compared with losses from conventional knife application. All losses are very low, although those with the knife application are the lowest. The highest loss figure of 1.04 percent at the very shallow plowing depth of 3 inches represents a nitrogen loss of only about 10 cents an acre at current prices.

Studies of the amount of ammonia diffusion in the soil showed that spacings as close as 8 inches could be used. With the 8-inch spacing and the same rate of ammonia release used in these tests, rates as high as 750 pounds per acre should not increase the percentage losses.

However anhydrous ammonia is applied, uneven ground, extreme cloddiness, excess trash, and other unusual conditions can increase losses, even causing visible or "smoking" losses. Visible losses did not occur where the soil was friable and left well-leveled after tillage.

Research to date has shown that ammonia can be applied during tillage with very low losses. A good job of tillage must be done, and the ammonia released under a fairly loose soil. If visible losses occur, they can be decreased by leveling the soil behind the plow or disk, dragging loose soil over the line of release, or using deeper tillage with deeper ammonia placement.

Any tillage tool permitting ammonia release at a depth of more than 4 inches with loose soil above that depth can probably be used to apply anhydrous ammonia. Such implements would include moldboard and disk plows, several types of disk harrows, spring-tooth harrows, field cultivators, and subsoilers.

U. Ill., Col. Agr., Urbana, Ill.

Ward, C. Y., and Blaser, R. E. EFFECT OF NITROGEN FERTILIZER ON EMERGENCE AND SEEDLING GROWTH OF FORAGE PLANTS AND SUBSEQUENT PRODUCTION. Agron. J. 53: 115-120. 1961.

Alfalfa, red clover, birdsfoot trefoil, and Ladino clover were each seeded alone and with orchardgrass and received 0, 20, 40, or 80 pounds of nitrogen fertilizer at or just prior to seeding. A new seeding was made in the spring of each of 3 years. The effects of nitrogen applied at seeding time were:

1. The number of legume and orchardgrass plants emerging per unit area of soil decreased as the amount of nitrogen applied increased; an exception was Ladino clover in 1958 when a reduction in stand occurred only with the 80-pound rate of nitrogen.

2. The seedling weights of legumes and orchardgrass taken 28 days after emergence were not influenced by the nitrogen fertilizer.

3. The seedling weights of all legume species and orchardgrass taken 56 days after emergence for all years were greatest for the 80-pound rate of nitrogen. The response to 20 or 40 pounds of nitrogen varied for species and years.

4. Yields of the species or mixtures (weeds inclusive) were not improved by nitrogen fertilizers during the seedling year. The mean yields of the legume fraction of the sods were reduced by 80 pounds of nitrogen, the clovers being reduced more than alfalfa or birdsfoot trefoil.

5. Yields for the season after establishment show that the clovers were depressed by nitrogen in 2 of the 3 years. Alfalfa and trefoil yields were unchanged in 2 of the 3 years and increased with the 20-pound rate during 1 year.

Va. Agr. Expt. Sta., Blacksburg, Va.



Jones, M. B., Martin, W. E., Berry, L. J., and Osterli, V. GROUND COVER AND PLANTS PRESENT ON GRAZED ANNUAL RANGE AS AFFECTED BY NITROGEN FERTILIZATION. J. Range Managt. 14: 146-148. 1961.

Botanical composition was measured on nitrogen fertilized and unfertilized range at 11 locations in the California annual type range. Nitrogen fertilization increased the percentage of the ground covered by plants. Annual grasses and filaree were the plants contributing to the increased ground cover on the fertilized pastures. In general, undesirable annual grasses did not dominate and crowd out the more desirable grass species where nitrogen fertilizer was applied. The percentage of the ground covered by legumes was reduced where nitrogen was applied the same season of sampling, but where nitrogen had been applied previous years and not in the season of sampling the percentage ground cover of legumes had either not changed or had increased slightly on the fertilized areas.

U. Calif., Hopland Field Sta., Hopland, Calif.

Dubetz, S. EFFECTS OF SOIL TYPE, SOIL MOISTURE, AND NITROGEN FERTILIZER ON THE GROWTH OF SPRING WHEAT. Canad. J. Soil Sci. 41: 44-51. 1961.

Spring wheat was grown in the greenhouse on two soil types (Lethbridge 1 and Cavendish 1s) with nitrogen rates of 0, 30, 60, and 90 pounds per acre and at three moisture levels--field capacity to 3/4 field capacity, field capacity to 1/2 field capacity, and field capacity to 1/4 field capacity. Significant increases in yield of grain and significant decreases in percentage protein were obtained with increasing soil moisture on a loam soil but not on a loamy sand. Apparently, the difference in plant growth between soils may be attributed to the greater changes in moisture tension of the loam soil within the moisture ranges studied. The loam soil was also watered less frequently and the high moisture tensions were of longer duration.

Both soils showed significant increases in yield of grain with increasing nitrogen fertilizer, but significant increases in percentage protein were obtained on the loam soil only. The largest yield increase per unit of nitrogen was obtained on the loamy sand. The growth of wheat on the loam soil was significantly superior in all respects except for the roots of that on the loamy sand. This is explained on the basis of differences in the original fertility of the two soils before treatment.

Canada Dept. Agr. Res. Sta., Lethbridge, Alberta, Canada.

Boatwright, G. O., and Haas, H. J. DEVELOPMENT AND COMPOSITION OF SPRING WHEAT AS INFLUENCED BY NITROGEN AND PHOSPHORUS FERTILIZATION. Agron. J. 53: 33-36. 1961.

Influence of N, alone and in combination with P, on development and composition of component parts of spring wheat at successive stages of growth was studied under dryland field conditions. Maturity was hastened and growth and nutrient uptake by the entire plant were increased by fertilization. Maximum dry weight and N uptake from NP-fertilized, N-fertilized, and unfertilized plots occurred at heading, soft dough, and maturity, respectively. Maximum P uptake by the plants occurred by heading irrespective of treatment. Losses in dry weight and plant nutrients from the entire plant subsequent to maximum points were attributed to sampling error, mechanical loss of plant parts, or a return of materials to the roots. Losses in leaves, stems, and chaff were also attributed to translocation from these parts to the grain. Concentration of N and

P in the plant tissue was highest during the early stages of plant development, but decreased rapidly until maturity. Fertilization resulted in highest concentrations of both N and P in all component parts.

Since fertilized plants attained maximum dry weight and N and P uptake by heading, grain production appeared more dependent upon transfer of nutrients from other plant parts than upon absorption from the soil during the period of grain formation.

SWCRD, ARS, USDA, Bozeman, Mont.

Vlams, J., and Gowans, K. D. AVAILABILITY OF NITROGEN, PHOSPHORUS, AND SULFUR AFTER BRUSH BURNING. J. Range Managt. 14: 38-40. 1961.

A Parrish 1 soil from the foothills of western Tehama County, Calif., was sampled from the surface 8 inches of a brush burned area and tested in the greenhouse for mineral deficiencies by means of pot tests. An unburned area adjacent to the burn was also sampled as a control.

Lettuce and barley plants were grown for 6 weeks in 6-inch pots containing 1,600 grams of soil each. Nutrient combinations of nitrogen, phosphorus, potassium, and sulfur were used.

The unburned soil showed distinct responses to the application of nitrogen, phosphorus, and sulfur with both crops. The burned soil showed only slight responses to these nutrients. The unfertilized soil from the burned area gave substantially higher yields than the unburned soil. It was concluded that burning a vegetative cover increases the supply of nitrogen, phosphorus, and sulfur available for plant growth in the soil.

U. Calif., Davis, Calif.

Eik, K., Webb, J. R., Black, C. A., Smith, C. M., and Pesek, J. T. EVALUATION OF RESIDUAL EFFECTS OF PHOSPHATE FERTILIZATION BY LABORATORY AND PLANT-RESPONSE METHODS. Soil Sci. Soc. Amer. Proc. 25: 21-24. 1961.

Samples of soil were collected in 1955 from three field experiments in which 0, 13.1, 26.2, 52.3, and 104.7 pounds of P per acre had been applied as superphosphate to one series of plots in 1953 and to a second series in 1954. In a greenhouse experiment conducted in 1957, sorghum was grown on quantities of these samples without further phosphate fertilization and on quantities of the samples from the control plots after treatment with superphosphate at rates equivalent to those applied in the field. Conditions in the greenhouse experiment were such that the yield of P in the test crop increased linearly with the quantity of P applied to each soil in each year.

Samples of soil from all phosphate levels and years of applications were analyzed in the laboratory for labile inorganic P by the 0.025N HCl, 0.03N  $\text{NH}_4\text{F}$  method of Bray and Kurtz, the anion-exchange resin method of Amer *et al.*, and the  $\text{NaHCO}_3$  method of Olsen *et al.* The quantity of P extracted with each method increased linearly with the quantity of P applied to each soil in each year. The ratios of the slopes of the linear plots of yield of P obtained with the 1953 and 1954 applications were calculated for samples of soil from each of the three field experiments, and these were designated as availability-coefficient ratios of residual and currently-applied P. Corresponding slope ratios calculated from the quantities of labile P extracted were designated as extractability-coefficient ratios of residual and currently-applied P. The six availability-coefficient ratios obtained from the two residual years in the three experiments were correlated with the corresponding extractability-coefficient ratios, the best correlation ( $r = 0.98$ ) was obtained with extractability-coefficient ratios derived from

the 0.025N HCl, 0.03N  $\text{NH}_4\text{F}$  method, second best ( $r = 0.90$ ) with the anion-exchange resin method, and third best ( $r = 0.51$ ) with the  $\text{NaHCO}_3$  method. These results show that appropriate laboratory tests provided an estimate of the relative residual value of fertilizer P that was largely independent of the nature of the soil.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Mack, A. R., and Barber, S. A. INFLUENCE OF TEMPERATURE AND MOISTURE ON SOIL PHOSPHORUS: I. EFFECT ON SOIL PHOSPHORUS FRACTIONS. Soil Sci. Soc. Amer. Proc. 24: 381-385. 1960.

Soil incubated at  $-20.5^\circ\text{C}$ . for 9 months released more phosphorus when leached with water than soil incubated at  $2.7^\circ\text{C}$ . At a leaching temperature  $32^\circ\text{C}$ . more phosphorus was released than at  $16^\circ\text{C}$ . The amount of phosphorus released was correlated with a decrease in acid-soluble phosphorus (iron phosphate) in the soil after leaching. It is suggested that preconditioning temperature changes either the types of phosphorus compounds or the surface area of those present in the soil. Incubating under anaerobic conditions increased the alkali-soluble phosphorus; however, this phosphorus did not contribute to the supply of phosphorus available to the plant.

J. Paper 1526, Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Stanberry, C. O., Fuller, W. H., and Crawford, N. R. COMPARISON OF PHOSPHATE SOURCES FOR ALFALFA ON A CALCAREOUS SOIL. Soil Sci. Soc. Amer. Proc. 24: 364-368. 1960.

An evaluation of phosphate sources for alfalfa production was made on P-deficient Superstition fs under arid conditions. Factors studied included particle sizes and methods, rates, and frequencies of application. These factors were evaluated under field conditions in terms of: (1) Hay yields; (2) P composition of plants; (3) total P removed from the soil by the hay; and (4) estimated residual P in the soil over a 3-year cropping period using radio-phosphorus techniques.

Supplemental P applications increased hay yields an average of 38 percent, P percentage 25 percent, P yield 66 percent, and A value or residual P, 126 percent.

A 3-year summary demonstrated that dicalcium phosphate, if mixed thoroughly with Superstition soil, was at least as efficient as concentrated superphosphate in increasing alfalfa hay yields, P percentage of the hay, total P removed from the soil, and available residual P. The two particle sizes of dicalcium phosphate were equally effective for the 3-year period, but the finer, with greater surface area, appeared more efficient the first year.

The higher rate of application, 131 pounds P per acre, was 7 to 71 percent more effective than the 66-pound rate in increasing yield, P percentage, P yield, and A values. A single initial P application for the 3-year period was as effective as the same total amount applied annually. When applied properly, both particle sizes of dicalcium phosphate, the phosphoric acid, and concentrated superphosphate all appeared to be satisfactory phosphate sources.

SWCRD, ARS, USDA, Tucson, Ariz.

Welch, L. F., and Scott, A. D. AVAILABILITY OF NONEXCHANGEABLE SOIL POTASSIUM TO PLANTS AS AFFECTED BY ADDED POTASSIUM AND AMMONIUM. Soil Sci. Soc. Amer. Proc. 25: 102-104. 1961.

Undried Marshall and Clarion surface and subsoil samples were cropped in the greenhouse (short-term cropping) to determine the effect of  $\text{NH}_4$  and K additions on the availability of nonexchangeable soil K to corn plants. When 0, 10, 25, 50, and 100 mg. of  $\text{NH}_4$  was added to 100 g. of soil, the corn absorbed 21.8,



16.4, 11.6, 4.96, and 0.12 mg. of nonexchangeable K from the Marshall surface soil and 5.19, 4.74, 3.55, 0.91, and -1.44 mg. from the Clarion surface soil. This reduction in the uptake of nonexchangeable K by plants was due to the blocking effect of  $\text{NH}_4$  on the release of K, and was not an effect of  $\text{NH}_4$  on the absorption of available K. Similar results were obtained with the Marshall subsoil. The Clarion subsoil did not release K even in the absence of added  $\text{NH}_4$ .

K additions reduced the release of nonexchangeable soil K. When  $\text{NH}_4$  and K were both added, the order of addition proved to be important because  $\text{NH}_4$  also blocked the release of added K that was fixed by the soil.

SWCRD, ARS, USDA, Watkinsville, Ga.

Cook, J. A., and Carlson, C. V. CALIFORNIA VINEYARDS RESPOND TO POTASH... WHEN NEEDED. Better Crops With Plant Foods 45(3): 2-11. 1961.

Numerous field trials indicate potassium deficiency is not extensive enough to warrant general fertilization of California's nearly one-half million acres of vineyards.

Soil analysis for exchangeable potassium does not seem to be a reliable indication of potash need. Potassium content of foliage tissues, especially leaf petioles, offers much promise as a guide to potassium status, although current data are too limited for general use.

Until conclusive, calibrative correlation can be developed between tissue potassium levels and yield responses, heavy potassium sulfate treatments necessary for uptake by California grapevines should be restricted to localized areas that show visual deficiency. Such areas are individually small (seldom over an acre) but quite frequent in vineyards of the San Joaquin Valley.

Experience has shown, potassium deficiency in California is corrected better by infrequent massive doses - 1,000 to more than 2,000 pounds of potassium sulfate per acre - than by much smaller rates at annual intervals.

U. Calif., Davis, Calif.

Lang, A. L., and Martin, C. K. LIQUID FERTILIZERS AS GOOD AS DRY ONES. Ill. Res. 2(4): 14. 1960.

Liquid soluble fertilizers are becoming increasingly popular in Illinois. The most common ones contain only nitrogen; or nitrogen and phosphorus; or nitrogen, phosphorus, and potassium.

That their use is justified is indicated by University of Illinois experiments. For 2 years in a row, liquid fertilizers have increased corn yields as much as dry fertilizers.

In 1958, tests were conducted at Elwood and at two locations in Urbana. The following year, tests were conducted at Elwood and Mahomet. The soil type at Elwood was Symerton sil; at Urbana, Drummer sicl; and at Mahomet, a Catlin-like sil.

Regardless of the form of fertilizer, if enough plant nutrients were added to meet soil test requirements, yields were markedly increased. Average increase for all experiments was 17-1/2 bushels an acre. Liquid mixes produced a 19-bushel increase; and drymixes, a 16-bushel increase. The 3-bushel increase in favor of the liquids was not statistically significant.

In the early part of both seasons, corn receiving starter fertilizer grew markedly better than that receiving just the broadcast fertilizer. This initial growth, however, did not significantly increase yields. The amount of early growth was about the same for the liquid form of the starter fertilizer as for the dry form.

From the results obtained with liquid fertilizers, one can say that they offer another source of plant nutrients. They seem to be just as good as, but no

better than other sources. Whether they should be used depends on how well they fit an individual's needs, on the convenience of handling and applying, and on the price per unit of plant nutrients.

U. Ill., Col. Agr., Urbana, Ill.

Molberg, E. S. INJURIOUS EFFECTS OF FERTILIZERS APPLIED WITH THE SEED ON THE EMERGENCE OF FLAX. *Canad. J. Soil Sci.* 41: 35-43. 1961.

Several fertilizer formulations were placed with the seed of Rocket flax at various rates to observe their effects on emergence.

In field tests, 20 pounds of nitrogen per acre placed with the seed significantly reduced emergence. When broadcast, 80 pounds caused no reduction in stand, and yields were increased. Whenever the fertilizer treatments reduced the stand of flax to 43 plants per foot of row or less, yields were reduced. This number of plants corresponds to a seeding rate of approximately 36 pounds per acre.

In greenhouse tests, it was generally safe to apply up to 15 pounds of nitrogen with flax seed if soil moisture was adequate.  $P_2O_5$  in the form of mono-ammonium phosphate could be safely applied at rates from 5 to 20 pounds, depending on the N: $P_2O_5$  analysis of the fertilizer. The greater the amount of N in the fertilizer, the less  $P_2O_5$  could be used. Results with mono-calcium phosphate were more erratic and generally less satisfactory than with mono-ammonium phosphate. The former could not be used safely at rates above 15 pounds  $P_2O_5$  per acre.

Damage to flax from commercial fertilizers was greater when the moisture content of the soil was low. The results indicated that fertilizers at normal rates should not be applied in close contact with flax seed unless there is adequate moisture for germination and growth.

Canada Dept. Agr., Regina, Saskatchewan, Canada.

Carlson, C. W., Grunes, D. L., Alessi, J., and Reichman, G. A. CORN GROWTH ON GARDENA SURFACE AND SUBSOIL AS AFFECTED BY APPLICATIONS OF FERTILIZER AND MANURE. *Soil Sci. Soc. Amer. Proc.* 25: 44-47. 1961.

A study was conducted in the field to evaluate the fertility requirements of a Gardena fsl subsoil as compared to an undisturbed soil. Corn was grown on both areas the first and third years after land leveling.

Where the topsoil had been removed, the most deficient element was N, followed by P and Zn. Zn increased corn grain yields both the year it was applied, and 2 years later. Manure applied the first year after leveling increased corn yields that year, and supplied residual P and Zn 2 years later. However, the yields on manured plots were not as high as those obtained with applications of N, P, and Zn.

Applications of N and P increased yields slightly on the undisturbed area. It was necessary to apply N, P, Zn, and manure to make yields on the subsoil equal those on the surface soil.

SWCRD, ARS, USDA, Beltsville, Md.

Cummins, D. C., and Parks, W. L. THE GERMINATION OF CORN AND WHEAT AS AFFECTED BY VARIOUS FERTILIZER SALTS AT DIFFERENT SOIL TEMPERATURES. *Soil Sci. Soc. Amer. Proc.* 25: 47-49. 1961.

Corn and wheat were germinated at different concentrations of various fertilizers in growth chambers. Three temperature levels (50°, 68°, and 86° F.) were maintained in the controlled tests. The fertilizers ranked in the following

order with decreasing detrimental effects on the germination of corn: anhydrous ammonia, urea, nitrate of soda, muriate of potash, ammonium nitrate, ammonium sulfate, 6-12-12 fertilizer, sulfate of potash, 48 percent superphosphate, and 20 percent superphosphate. The fertilizers ranked in the following order with decreasing detrimental effects on the germination of wheat: anhydrous ammonia, urea, muriate of potash, nitrate of soda, ammonium nitrate, ammonium sulfate, sulfate of potash, 6-12-12 fertilizer, 48 percent superphosphate, and 20 percent superphosphate. Corn was tolerant to a higher salt concentration than was wheat. The nitrogen and potash fertilizers were more detrimental to germination than were the phosphate fertilizers. The temperatures studied had no significant effect on the tolerance of corn and wheat to salt concentration. Corn did not germinate at 50° F.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Nakoneshny, W., and Friesen, G. THE INFLUENCE OF A COMMERCIAL FERTILIZER TREATMENT ON WEED COMPETITION IN SPRING SOWN WHEAT. *Canad. J. Plant Sci.* 41: 231-238. 1961.

Applications of ammonium phosphate fertilizer (11-48-0) at 40 pounds per acre on six farm fields in Manitoba were effective in reducing losses in wheat yields caused by weed competition. Average losses in yield due to weed competition were 20.5 percent in unfertilized portions of the fields and only 11.7 percent in fertilized portions of the same fields. Increases in wheat yields resulting from fertilized treatment were approximately equal to increases resulting from weed removal. Higher yields resulting from fertilizer treatment were sometimes accompanied by decreases in the protein content of the harvested crop. Increased yields resulting from weed removal were generally accompanied by significant increases in the protein content. The combined effects of fertilizer treatment and of weed removal produced the largest increases in yield of wheat and maintained the protein content at a comparatively high level.

Agr. Res. Off., Res. Br., Canada Dept. Agr., Fort Vermillion, Alberta, Canada.

Dregne, H. E., Breshears, C. A., and Gomez, R. S. FERTILIZER AND WATER RELATIONS IN THREE HIGH PLAINS SOILS. *N. Mex. Agr. Expt. Sta. Res. Rpt.* 53, 13 pp. 1961.

Greenhouse studies were made to determine differences in fertilizer response and efficiency of water use among similar soils having only moderate differences in texture. Three sandy loam soils--two from the Amarillo series and one from the Pullman series--were used. All three soils came from Curry County, New Mexico.

All three soils responded favorably to nitrogen, but potassium depressed yields on the Pullman soil. Barley yields on the unfertilized soils were better on those containing less sand. Fertilizer increased the efficiency of water use; efficiency was lowest on the unfertilized soil with the higher sand content. Straw-root ratios differed among the barley grown on the three soils, but the differences were not statistically related to treatment.

N. Mex. State U., Agr. Expt. Sta. University Park, N. Mex.

Norris, M. J., Hill, H. O., and Fisher, F. L. GRAIN SORGHUM FERTILIZER TESTS ON UPLAND CLAY SOILS OF CENTRAL TEXAS, 1953-59. *Tex. Agr. Expt. Sta. MP-475*, 7 pp. 1960.

The results of fertilizer tests made on grain sorghum at the Texas Agricultural Experiment Station, Substation No. 23, McGregor, during 1953-59 are summarized. The experiments were conducted without irrigation on upland Grand Prairie and Blackland Prairie soils.



Nitrogen and phosphorus fertilizers consistently gave increased yields of grain sorghum. Responses to phosphorus were greater than responses to nitrogen, but the highest yields were obtained when both nitrogen and phosphoric acid were used. Generally, the minimum rate of nitrogen and phosphorus fertilizers gave the highest return on money invested for fertilizer. No yield responses were obtained from the application of potash. Experiments with varying nitrogen rates in the form of anhydrous ammonia gave responses similar to the same nitrogen rates using solid fertilizers.

Applications of 15 to 30 pounds of both nitrogen and phosphoric acid per acre are recommended for grain sorghum on the upland clay soils without irrigation. The recommendations are 100 to 200 pounds per acre of 15-15-0 or 16-20-0 fertilizers in terms of fertilizer grades usually available to farmers. This should be applied at or before planting time but not in direct contact with the seed. Such fertilizer applications have paid 2 out of 3 years; production during the third year was limited by low moisture.

The time of applying nitrogen on continuous grain sorghum, studied during a 1-year period, indicates no differences in yield from the following three times of nitrogen application: (1) In the fall on the stubble of the previous crop; (2) a spring application at planting time; or (3) a split application with half of the nitrogen applied in the fall and the other half at planting time.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Fleming, H. K., Smith, C. B., and Kardos, L. T. HEAVY FERTILIZER APPLICATIONS IMPROVE MONTMORENCY CHERRY YIELDS. Sci. For The Farmer 8(4): 13. 1961.

Doubling the fertilizer application improved yield significantly in an Erie County Montmorency sour red cherry orchard which was clean cultivated from early spring until a cover crop of domestic ryegrass was seeded in early August. Highest average annual yield of 6 fertilizer treatments compared over a 5-year period (see table) was from plots receiving an annual spring application of 1,000 pounds per acre of 10-6-4. Yield was almost as good where the fertilizer was 1,000 pounds of 10-10-10.

These results were obtained in a cooperative experiment in an orchard. The soil was Conottongravelly1. Fertilizers were broadcast in spring from the sixth through the fifteenth years from planting. Data in the table are from the last 5 years of the 10-year period.

Effects of soil management and fertilizer treatments on average annual yield of mature Montmorency cherry trees in Erie County over a 5-year period, 1952-56.

Treatment	Average Yield per Tree
Soil management*	Pounds
Clean cultivation	85.8
Ladino clover sod	86.2
L. S. D.	N. S.
Fertilizer treatments under clean cultivation	
A. 500 lbs./A 10-10-10	91.5
B. 500 lbs./A 5-10-10	80.2
C. 500 lbs./A 10- 0- 0	86.5
D. 500 lbs./A 10- 6- 4	84.4
E. 1000 lbs./A 10-10-10	99.7
F. 1000 lbs./A 10- 6- 4	106.5
L. S. D ( .05)	14.5
L. S. D. ( .01)	19.3

\*Averages of Treatments A and B only.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Caro-Costas, R., and Vicente-Chandler, J. EFFECT OF FERTILIZATION ON CARRYING CAPACITY AND BEEF PRODUCED BY NAPIERGRASS PASTURES. *Agron. J.* 53: 204-205. 1961.

The effects of applying 600, 1,800, and 3,000 pounds of 15-4-10 fertilizer per acre yearly on the productivity of steep napiergrass pastures were studied by grazing young cattle over a full 2-year period in the humid mountains of Puerto Rico under conditions which are typical of large areas in the humid tropics.

Gains in weight increased from 570 to 1,027 pounds per acre yearly; total digestible nutrients consumed by the livestock increased from 4,160 to 7,190 pounds per acre yearly; standard beef cows carried per acre increased from 0.95 to 1.64; dry forage consumed by the cattle went from 8,890 to 13,350 pounds per acre yearly; and protein content of the forage consumed, as determined by the difference method, rose from 8.1 to 15.9 percent when fertilizer rates were increased from 600 to 1,800 pounds of 15-4-10 per acre yearly. Cost of increased fertilization, including application, totalled about \$40 per acre compared to increased beef production worth about \$80. Increasing fertilizer rates to 3,000 pounds per acre yearly did not further increase the productivity of these pastures. Daily gains per head averaged 1.2 pounds irrespective of fertilization. The forage consumed was about 50 percent digestible, with about 13 pounds of dry forage required per pound of gain in weight.

SWCRD, ARS, USDA, Rio Predras, Puerto Rico.

Mergen, F., and Voigt, G. K. EFFECTS OF FERTILIZER APPLICATIONS ON TWO GENERATIONS OF SLASH PINE. *Soil Sci. Soc. Amer. Proc.* 24: 407-409. 1960.

A series of 37 plots was established on which three formulations of fertilizer were applied at five rates to two age-classes of slash pine growing in Florida. The fertilizer caused increases in the nutrient contents of needles and branches of the younger trees and of cones and seeds in the older trees. Basal-area growth was increased as much as 32 percent in the older trees. Fertilizer treatments had no significant effect on cone length but produced heavier seeds. When these seeds were germinated in the greenhouse, they produced larger more vigorous seedlings with higher contents of nitrogen, phosphorus, and potassium than did seeds produced on control trees.

The results suggest that it may be feasible to stimulate seed production on seed orchard trees through application of commercial fertilizers. The advantages of larger seeds and larger, more vigorous seedlings are undoubtedly sufficient, over an extended period, to justify the cost of the fertilizer.

Sch. Forestry, Yale U., New Haven, Conn.

Nearpass, D. C., and Clark, F. E. AVAILABILITY OF SULFUR TO RICE PLANTS IN SUBMERGED AND UPLAND SOIL. *Soil Sci. Soc. Amer. Proc.* 24: 385-387. 1960.

A deficiency disease of rice occurred on plants grown in Evesboro sl soil in pot culture, following submergence as customarily employed for lowland rice culture. This was apparently sulfur deficiency, since rice plants responded to various forms of sulfate sulfur in further pot tests.

In comparison experiments, sulfur uptake by rice plants was reduced by submerging the soil. In one experiment, testing 5 levels of available sulfur in Evesboro sl soil, parabolic and logarithmic equations were solved for the relationship between plant uptake of sulfur and available sulfur in the soil. When both types of equations were solved for the best fitting values of soil sulfur, the

values obtained in submerged and upland soil were comparable, indicating that both soil and fertilizer sulfur were subject to the same changes upon flooding.

In comparisons of submerged and upland conditions on five other soils, sulfur uptake was lowered by flooding the soil, regardless of the type of yield response, whether negative or positive, obtained from flooding. Sulfur percentage in the plants grown in flooded cultures was related to the yield response obtained from flooding. The soils which gave negative yield responses produced the lowest sulfur contents.

Organic matter, in the form of dried and ground rice plant tissue, when added to flooded cultures, depressed the growth of rice plants. Sulfate, added along with the organic matter, overcame to various degrees the depression in growth. Prior submergence also had an ameliorating effect on the growth depression which occurred with flooding and organic matter.

SWCRD, ARS, USDA, Beltsville, Md.

Seven scientists. ARE MINOR ELEMENTS IMPORTANT? Crops and Soils 13(7): 7-10. 1961.

Trace elements are nutrients which plants need only in small or minute amounts. Sometimes called minor elements or micronutrients, these vital nutritive elements are getting more attention as crop yields push higher and as plant and soil researchers use new techniques and instruments to probe the mysteries of plant growth. Seven trace nutrients--iron, manganese, boron, zinc, copper, chlorine, and molybdenum--are known to be essential for plant growth. Just recently, cobalt was proven necessary for legume growth. Here, seven scientists report on the need for trace elements in various regions of the United States.

The following reports are presented:

Berger, K. C. CORNBELT STATES. U. Wisc., Madison, Wisc.

Gammon, N., Jr. SOUTHEASTERN PLAIN. Fla. Agr. Expt. Sta., Gainesville, Fla.

Rhoades, H. F., and Chesnin, L. GREAT PLAINS. U. Nebr., Lincoln, Nebr.

Bingham, F. T. FAR WEST AND SOUTHWEST. Calif. Citrus Expt. Sta., Riverside, Calif.

Reisenauer, H. M. PACIFIC NORTHWEST. Wash. State U., Pullman, Wash.

Allaway, W. H. ANIMAL HEALTH. SWCRD, ARS, USDA, Ithaca, N. Y.

Barrows, H. L., Neff, M. S., and Gammon, N., Jr. EFFECT OF SOIL TYPE ON MOBILITY OF ZINC SULFATE TO TUNG. Soil Sci. Soc. Amer. Proc. 24: 367-372. 1960.

The effects of soil type on movement of zinc in the soil and of soil type and levels and placements of zinc sulfate on growth of 1-year-old tung trees was studied. The soils were Savannah and Red Bay fsl, Lakeland fs, and Arredondo lfs. The treatments consisted of the factorial combination of three levels of zinc sulfate with three placements and a check plot (no zinc sulfate).

At the end of 1 year the rate of zinc movement through the four soils was in the order Lakeland > Red Bay > Savannah > Arredondo. Very little zinc was absorbed by the tung trees from surface applications on the Arredondo soil, but the



trees obtained sufficient zinc when the zinc sulfate was mixed with the soil. In contrast, zinc mobility on the Lakeland soil was so great that 1 ounce applied on the surface proved toxic.

Although there was little lateral movement of zinc in the soils, the movement was primarily toward the tree rather than away from it.

CRD, ARS, USDA, Bogalusa, La.

Lagace, A., Bell, D. S., Pounden, W. D., and Moxon, A. L. SELENIUM CAN PREVENT LAMB DISEASE. Ohio Farm and Home Res. 46: 7. 1961.

White muscle or "stiff lamb" disease is an ailment that has plagued nursing lambs 4 to 10 weeks of age in many Ohio flocks. For a number of years this disease was thought to be a result of vitamin E deficiency and treatment on this basis was recommended. More recently, the trace element, selenium, was found to be involved.

In a study of a farm flock that had the white muscle disease, the authors concluded that selenium appears to be useful in the prevention of the disease when injected subcutaneously at the rate of 1 milligram every 10 days.

In this experiment, the use of pasture was as effective as injection with selenium to control the disease.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Misra, S. G., and Sharma, M. D. STUDIES ON THE RELEASE OF ADSORBED COPPER BY SOILS AND COMPOST. Soil and Plant Food 6(3): 103-105. 1961.

Copper deficiency has been observed in soils rich in organic matter such as peat or in light mineral soils derived from silica and carbonate rich sediment. The deficiency can be corrected by adding copper sulfate in different doses. Also, the unavailable copper can be made available by increasing the acidity of soils by some means. It has been suggested that copper forms complexes with organic compounds present in the soil and gets fixed by the mineral exchange materials, and thereby becomes unavailable to plants.

The authors summarize their work as follows:  $\text{Cu}^{++}$  ions are adsorbed from copper sulfate solution by soils and compost alike but the adsorption greatly depends upon  $\text{CaCO}_3$  content and pH of these materials. The adsorbed  $\text{Cu}^{++}$  is readily extracted by organic acid but the presence of neutral salts and alkalis does not affect the solubility of the adsorbed copper much and thus the copper applied under such conditions remains unavailable to the plants.

U. Allahabad, Allahabad, India.

Kliwer, W. M., and Kennedy, W. K. STUDIES ON RESPONSE OF LEGUMES TO MOLYBDENUM AND LIME FERTILIZATION ON MARDIN SILT LOAM SOIL. Soil Sci. Soc. Amer. Proc. 24: 377-380. 1960.

Greenhouse experiments were conducted on Mardin sil to determine the response of alfalfa, birdsfoot trefoil, ladino, and red clover to Mo applied alone and in combination with different increments of lime and P. Two strains of birdsfoot trefoil Rhizobium were also compared for differences in response to Mo and lime. These treatments were evaluated in terms of dry matter production and content of total N and Mo in forage and roots. The effect of these treatments on nodulation was studied with birdsfoot trefoil.

All legumes responded to Mo as shown by increases in yield and N content of forage and roots. Birdsfoot trefoil showed the greatest response to Mo. An interaction between Mo and lime was found for alfalfa, birdsfoot trefoil, and ladino clover. Mo applied with lime at rates less than 2 tons per acre increased

the yield and N content of the forage. At 2 tons of lime per acre or greater, there was no response to the addition of Mo.

A direct relationship existed between soil pH and Mo content of the forage birdsfoot trefoil. Four to five tenths p.p.m. Mo in the forage was found to be adequate for maximum growth.

Molybdenum increased the size of individual nodules and reduced the total number of nodules on birdsfoot trefoil plants. A correlation existed between the number of nodules per plant and the N content of the forage.

The strain of Rhizobium or level of P did not affect yields or N content of forage or roots.

Yields from treatments that received 2 tons of lime per acre were always greater than those receiving less lime, whether or not No was added. Yield and N data suggest that when lime was applied at a rate of 2 tons per acre or greater it had an additional effect besides increasing the availability of Mo, P, or providing a suitable environment for Rhizobia bacteria. This was especially pronounced in alfalfa and to a lesser degree with birdsfoot trefoil and the clovers. A possible reason for this is given in the discussion.

Agron. Paper 499, Cornell U., Ithaca, N. Y.

Chichilo, P., and Whittaker, C. W. TRACE ELEMENTS IN AGRICULTURAL LIMESTONES OF THE UNITED STATES. Agron. J. 53: 139-144. 1961.

A study was made of the contribution of applied limestone to soil supplies of trace and other elements. Seventeen elements were determined by chemical and spectrographic means in 220 samples of liming materials supplied by 158 producers in 35 States. The following ranges (and averages) were found among 194 agricultural limestone samples: calcium carbonate 44.90 to 99.29 (75.43) %, magnesium carbonate 0.15 to 44.59 (17.08) %, silicon 0.03 to 15.53 (2.36) %, aluminum 0.01 to 2.15 (0.45) %, iron 0.01 to 3.11 (0.43) %, potassium < 0.001 to 1.795 (0.228) %, sulfur < 0.01 to 1.35 (0.11) %, sodium < 0.001 to 0.148 (0.030) %, manganese 20 to 3000 (330) p.p.m., fluorine < 10 to 1410 (230) p.p.m., phosphorus 10 to 3660 (210) p.p.m., zinc < 1 to 425 (31) p.p.m., vanadium < 1 to 106 (11) p.p.m., boron < 1 to 21 (4) p.p.m., copper < 0.3 to 89.0 (2.7) p.p.m., molybdenum < 0.1 to 92.3 (1.1) p.p.m., and cobalt < 1 to 6 (<1) p.p.m.

Silicon is very highly correlated with impurities ( $r = 0.962$ ) and much less, though significantly, with the  $\text{CaCO}_3/\text{MgCO}_3$  ratio ( $r = -0.161$ ). Aluminum, potassium, cobalt, iron, sodium, boron, vanadium, manganese, fluorine, and sulfur are significantly correlated with both total impurities and silicon. Compared to the composition of the unquarried rock, agricultural limestone tends to have a higher trace element content, which is attributed to contamination from processing equipment and overburden. High amounts of iron, manganese, copper, cobalt, and zinc were found among three byproduct materials of the lead-zinc mining industry. A residue from the production of chemical lime had a high calcium carbonate equivalence but no unusual amounts of other elements. Sugar beet refuse lime was relatively high in phosphorus and copper. The percentages of the 194 agricultural limestone samples containing the equivalent of, or more than, the average amounts of important elements removed by cropping are, for each element: manganese, 72; iron, 99; magnesium, 85; molybdenum, 10; zinc, 12; cobalt, 19; sulfur, 3; and copper, 2. The percentages of these samples containing the equivalent of or more than the lowest amounts of elements added to correct deficiencies are: for molybdenum, 55; for manganese, 24; and for zinc, 3.

SWCRD, ARS, USDA, Beltsville, Md.

Abichandani, C. T., and Patnaik, S. EFFECT OF LIME APPLICATION ON NITROGEN AVAILABILITY AND RICE YIELDS IN WATER-LOGGED SOILS. J. Indian Soc. Soil Sci. 9(1): 55-62. 1961.

Effect of lime application on nitrogen availability and rice yields in water-logged soils was investigated. Lime application was seen to mineralize soil organic nitrogen and make additional ammonium nitrogen available for crop utilization. Under field conditions, 2,000 lb. lime per acre increased initial soil reaction by one to two pH units and ammonium nitrogen content nearly two-fold.

Significant increase in yield of grain due to lime application at 2,000 lb. per acre was observed. Lime response in combination with nitrogen fertilizer tended to decrease with increase in nitrogen supply. Lime response was higher with phosphate fertilizer than without it. Lime effect was seen to be marked only during the year of application and no residual effect of lime application was seen in the year succeeding its application.

Influence of lime application to soil for increasing rice yields, appears to have limitations of using rather high doses of lime.

Cent. Rice Res. Inst., Cuttack, Orissa, India.

Johnson, P. R. EFFECT OF LIME ON SILAGE PRODUCTION IN NORTHEAST TEXAS. Tex. Agr. Expt. Sta. Prog. Rpt. 2170, 3 pp. 1961.

Many East Texas soils are lacking in lime and many are lacking in both lime and magnesium. This has been brought about by natural leaching, longtime cropping, and the use of acid-forming fertilizers.

Magnesium deficiency symptoms of sorghum are similar to those of corn; that is, the leaves will show yellowish-white stripes. On small seedlings, the symptoms are not as easily recognized. Calcium deficiency apparently results in stunted seedlings with reddish-brown spots that may cover part or most of the leaves. The tips of the leaves may not unfold. The leaves may die, and in severe cases the entire plant will die. The older roots will be brown and dying. Younger roots will be short and stubby. These symptoms are similar to those of some leaf diseases and soil-borne nematodes. Sorghum seedlings grown on sterilized calcium-deficient soil show the same symptoms as those on soils known to infested with meadow nematodes. Plants on cold, wet soil are more susceptible to loss of stand than those on more favorable sites, or in more favorable seasons.

The use of lime has been profitable in the production of sorghum silage where soil tests indicated a need. One ton per acre has been the most profitable rate, per dollar invested, for the 2-year period tested. The use of magnesium in combination with lime, either as dolomite or as magnesium sulfate, has shown some increase in yields. A longer period will be required to realize the full benefits of either limestone or dolomite. There was no evidence of over-liming when 2 tons of lime or 4 tons of dolomite were applied to a very sandy soil.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Shoop, G., J., Brooks, C. R., Blaser, R. E., and Thomas, G. W. DIFFERENTIAL RESPONSES OF GRASSES AND LEGUMES TO LIMING AND PHOSPHORUS FERTILIZATION. Agron. J. 53: 111-115. 1961.

In greenhouse studies using an acid, infertile subsoil material, tall fescue, redtop, Ladino clover, and Sericea lespedeza responded differently to liming and phosphorus fertilization. All species showed a response to lime as early as 2 weeks after planting. Data from the lime and phosphorus studies showed: (1) All species required phosphorus fertilization for normal growth; (2) redtop tolerated



acid soils exceedingly well where adequate phosphorus was supplied; (3) good growth of tall fescue was obtained with high rates of phosphorus on acid soils or with lower rates of phosphorus on limed soils; (4) Ladino clover grow well only on limed soils with adequate phosphorus fertilization; and (5) the tolerance of *Sericea lespedeza* to acid soils was intermediate to that of redtop and tall fescue.

Increases in plant growth (dry matter yield of tops and root growth) with increasing rates of lime were related to the levels of calcium and exchangeable aluminum found in the soils at different lime levels. The growth of the roots of Ladino clover and tall fescue was retarded in unlimed soils and the retardation was attributed to the toxic effect of aluminum.

Calcium content of the four species was generally increased by either addition of lime or of triple superphosphate on unlimed soils. Soil analysis data showed that additions of triple superphosphate or lime increased the available calcium content in the soil, and that liming or very high rates of triple superphosphate decreased the amount of exchangeable aluminum.

In a liming experiment with acid subsoil on a highway cut-slope, it was shown that liming increased the percent fescue in a fescue-redtop-clover mixture. Seedling weights of fescue and clover in the mixture were increased by liming, but seedling weights of redtop were not significantly affected by liming.

Va. Agr. Expt. Sta., Blacksburg, Va.

Gamble, S. J., and Kenworthy, A. L. SOIL pH IN RELATION TO DIFFERENT LIMING MATERIALS APPLIED TO AN APPLE AND A PEACH ORCHARD. Mich. State U. Q. B. 43(4): 695-699. 1961.

Eight liming materials were compared by making surface applications at the rate of 2 tons per acre in commercial orchards in 1954 and 1956. Soil samples were taken in 1959 and tested for pH according to standard methods.

Results indicated a greater effectiveness of the materials composed of dolomitic limestones in the hydroxide form. After 3 and 5 years, the hydroxide materials remained more effective as acid neutralizers than the carbonate materials. The importance of the dolomitic form of limestone was indicated by noting that the order of effectiveness was related to the neutralizing values.

Dolomitic hydrate, since it supplies the nutrient element magnesium and is an effective neutralizer of soil acidity, should be the major liming material used in Michigan orchards.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Box, J., and Walker, H. J. COTTON BURS FOR SOIL IMPROVEMENT. Tex. Agr. Expt. Sta. MP-476, 7 pp. 1960.

Use gin wastes where possible for more efficient production of field crops. Over a 6-year period, cotton burs increased yield by an average of about 36 pounds of lint cotton for each ton of burs applied. Water utilization efficiency was improved by about a third at the 6-ton per acre rate of application. This value has been proved in widely separate locations and on many soil types throughout Texas.

Cotton burs exert their main influence as organic material in the soil. Research tests show that after applying cotton burs for 6 years at various rates, only slight changes occurred in the organic content of the soil. There was a slight increase in phosphoric acid content in the surface and a slight decrease at lower levels.

The main value obtained from applying burs to the soil appears to be an increased supply of energy which was used by the soil microorganisms in breaking down the material and the later release of plant food nutrients contained in the burs.

The low content of organic matter in Texas soils need not be a cause for alarm, if liberal additions of organic residues are applied at regular intervals. Under Texas conditions, it is doubtful that economic benefits can be obtained by trying to raise the organic matter content of any cultivated soil above that of a virgin soil of the same type or classification. Soils which show a low organic matter content in the virgin state point out the need for a sound maintenance program that will return good increases in yields from regular applications of organic matter.

Cotton burs and other crop residues are relatively high in carbon and low in nitrogen. Their decomposition process temporarily uses up much of the available nitrogen in the soil. To avoid this situation, apply burs well in advance of the crop season or supplement them with additional nitrogen from a chemical source.

Nitrogen plowed down with cotton burs is beneficial in the following ways: (1) It hastens the transformation of cotton burs into active organic matter; (2) it results in a larger amount of active organic matter from a given quantity of crude cotton burs; (3) it provides an additional supply of available nitrogen for the crop that follows; and (4) it prevents any depression in yield which may result from plowing down heavy applications of cotton burs which are high in woody materials and low in nitrogen.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Lunt, H. A. SEWAGE SLUDGE IMPROVES SOIL. Crops and Soils 13(5): 14-15. 1961.

Digested sewage sludge, as produced in many city treatment plants will improve soil structure and tilth. It has a more lasting effect than barn manure and will increase crop yields, when properly used.

Sewage sludges vary widely in composition and properties depending on the treatment and source of sewage, but they can be grouped in three general classes as follows: (1) Raw sludge, also known as settled or primary sludge, is lumpy, has a strong offensive odor, is a potential carrier of disease bacteria and should not be used on any soil. However, it is used as a source of organic fertilizer in many countries of the world. (2) Digested sludge may be of several kinds, depending on the process used in the sewage treatment plant. Decomposition takes place in the absence of air, lowering the organic matter content and destroying most of the disease bacteria. The material is then partially dried. And (3) activated sludge is made by inoculating primary sludge with previously processed sludge and supplying large amounts of air for decomposition. The material is then dried, ground, and bagged as fertilizer. This type of sludge is relatively high in nitrogen and free of disease organisms.

Digested sludges vary widely in reaction from acid to alkaline, and the organic matter content ranges from 25 to more than 60 percent. In addition to nitrogen, sludges contain some phosphorus, and relatively large amounts of zinc, copper, boron, and manganese.

The application rate should be based more on the nitrogen content of sludge than on organic matter content.

Caution should be taken in that acid sludges, especially those from sewage containing industrial wastes, may be toxic to some crops when used on acid soils. Copper or zinc in these sludges, together with the resulting iron deficiency, will cause toxicity damage.

Crop injury is less likely to occur on neutral and alkaline soils. Furthermore, the harmful effect of acid sludges on acid soils can be avoided by liming the soil to pH 6.0 or higher.

Sludge can be used at high rates of 150 to 250 cubic yards per acre under some conditions, especially for such crops as small grains and grasses. These crops respond well to fairly heavy applications of sludge, even on acid soils. However, 50 cubic yards per acre is a safer rate.

Sludge should be allowed to weather for 6 to 12 months before being applied. This improves the granulation and makes it easier to spread the material. Also, state health departments may have a ruling against use of freshly digested sludge on crops or vegetables that are to be eaten raw. To eliminate many of these problems, fresh sludge should be worked into the soil 6 months before seeding or planting these crops.

Lunt Soil Lab., Northford, Conn.

Creamer, R. M. FERTILIZER-PESTICIDE MIXTURES: HOMOGENEITY OF FERTILIZER-PESTICIDE MIXTURES. Agr. Food Chem. 9(1): 26-29. 1961.

The use of fertilizer-pesticide mixtures has grown rapidly. Because mixtures prepared in the laboratory were relatively nonuniform, factors influencing their uniformity were evaluated. The mixtures were more uniform if insecticide were added as a solution than if added on a solid carrier. Mixing during addition of solution and use of closely sized fertilizer increased uniformity. The insecticide solution was preferentially adsorbed by the fine particles and by the phosphoric portions of a mixed fertilizer. The variation in insecticide content of random samples was large enough to cause poor analytical precision. Concentrations of the toxicant on the fine portions of the fertilizer contributes to nonuniformity and forms toxic dusts. Preferential adsorption of toxicant by certain portions of a mixed fertilizer may accelerate decomposition of the toxicant.

SWCRD, ARS, USDA, Beltsville, Md.

### Salinity and Alkali Problems

Yaalon, D. H. ON THE ORIGIN AND ACCUMULATION OF SALTS IN GROUNDWATER AND IN SOILS OF ISRAEL. Hebrew U. Jerusalem, Dept. Geol. P. 255, 42 pp. 1961.

The problem of the source of soluble salts in groundwater and in soils of Israel was examined and analyzed.

Both igneous and sedimentary rocks are generally poor in Cl and S, so that the salts released by weathering cannot alone explain the process of salinization. Fossil salt accumulations are a major factor only in certain regions. Oceanogenic airborne salts, being continuously blown inland and precipitated by rain, are the main source of soluble salts in coastal areas. In Israel, the concentration of chloride in the precipitation is highest in a narrow coastal belt and decreases inland to about 10 p.p.m. Cl, resulting in an average annual addition of about 8 kg. NaCl per dunam (17.63 lbs. per 1/4 acre). In the arid region, the dry salt deposition probably amounts to less than 0.2 kg. NaCl per dunam (0.44 lbs. per 1/4 acre) annually. For the country as a whole, the annual accession of airborne salts is estimated to be about 100,000 tons NaCl.

Before reaching the underground aquifer, the airborne salts dissolved in the rainwater are concentrated in the soil by evaporation. On passing through the soil, the composition of the salts changes due to ion exchange processes, through increment from weathering, and from dissolution of fossil salt accumulations or from connate waters of former sea inundations. The relative contribution of airborne salts can be estimated from the knowledge of groundwater recharge and the salinity of precipitation.

Geomorphic conditions favorable to salt accumulation in soils occur generally in areas of basin shaped topography, particularly when imported saline groundwater reaches close to the surface and if evapotranspiration exceeds precipitation, as in the marshy plains of the Coastal Plain and the Arava Valley. Weathering contributes only small amounts of soluble salts, with only local



exceptions. All saline soils in Israel are of the solonchak type. The position of the horizon of maximum salt accumulation is a function of the height of the water table and of the seasonal balance between precipitation and evaporation.

The accession of soluble salts in rain has also affected the Hamra sandy soil of the Coastal Plain, though soluble salts have not accumulated because of adequate leaching. The effect manifests itself in an increase in the adsorbed Na percentage and a decrease in the exchangeable Ca./mg. ratio.

The accession of airborne salts as a significant factor in soil formation has not been generally recognized in the past, but its evaluation is necessary for the proper understanding of soil development in coastal regions, for areas with depositional surfaces, and for arid regions in general.

Tables and maps

Dept. Geol., Hebrew U. Jerusalem, Jerusalem, Israel.

Kanwar, J. S. CLAY MINERALS IN SALINE ALKALI FOILS OF THE PUNJAB. J. Indian Soc. Soil Sci. 9(1): 35-40. 1961.

Clays less than 2 microns separated from four saline-alkali and one saline soil, representative of typical soils of the Punjab, were subjected to X-ray diffraction, differential thermal analysis, glycol adsorption, and chemical analysis. It was observed that the dominant clay mineral in these soils was illite, with some chlorite. There was little difference in the clay mineral composition of saline-alkali and normal soils of the same tract.

Gov't. Agr. Col., Ludhiana, Punjab, India.

Buras, N., Spencer, J. R., and Pillsbury, A. F. COST OF RECLAMATION AND DEVELOPMENT OF SOME SALINE LANDS. Trans. ASAE 4(1): 105. 1961.

A study was made of the costs involved in reclaiming and developing virgin saline land in the Coachella Valley of California. Included in the records are costs on three separate 40-acre parcels, all operated by one person.

The operations involved in the reclamation and development of the saline tracts of land were similar and representative of good practices. Major differences in costs can be summarized in two categories: (1) "low" for sparse vegetation and relatively smooth topography, and (2) "high" for heavy mesquite and rougher topography. Costs per acre, summarized in the Table below, ranged from \$560 to \$610.

TABLE. SUMMARY OF COSTS PER ACRE OF RECLAMATION AND DEVELOPMENT OF VIRGIN SALINE LAND, COACHELLA VALLEY, 1956-57

Operation	Tract A		Tract B	
	Low		High	
1 Land clearing		\$ 7.85		\$ 75.19
2 Surveying		6.00		6.00
3 Land leveling		171.22		193.08
4 Tile drainage		128.60		71.76
5 Other preleaching operations				
(a) Soil sampling	0.05		0.05	
(b) Tile backfill settlement	2.13		6.79	
(c) Regrading	1.13		4.25	
(d) Marking leaching borders	0.42		1.55	
(e) Subsoiling	19.35		19.35	
(f) Gypsum (including spreading)	19.00		28.50	
(g) Disking in gypsum	11.25		11.25	
(h) Erecting leaching borders	<u>15.73</u>	69.06	<u>15.76</u>	87.50

TABLE. SUMMARY OF COSTS PER ACRE OF RECLAMATION AND DEVELOPMENT OF  
VIRGIN SALINE LAND, COACHELLA VALLEY, 1956-57--Continued

Operation	Tract A		Tract B	
	Low		High	
6 Leaching				
(a) Water	11.17		11.17	
(b) Border patrols	<u>25.26</u>	36.43	<u>25.26</u>	36.43
7 Operations following leaching				
(a) Knocking down borders	14.95		14.95	
(b) Final leveling	23.06		23.06	
(c) Deep plowing	8.78		8.78	
(d) Disking	7.59		7.59	
(e) Land planing	<u>33.19</u>	87.58	<u>33.19</u>	87.58
8 Irrigation system		54.75		54.75
Grand total		561.49		612.29

At first glance, they may appear excessively high. However, a closer scrutiny shows that apart from topography and natural cover, other factors affect the cost of development of the type of lands studied. Among the important ones are:

(a) The occurrence of one or more clay lenses in the soil profile makes deep and costly subsoiling necessary.

(b) Extremely high salt content in the upper horizon requires large quantities of leaching water.

(c) Where exchangeable sodium appears to be sufficiently high, comparatively heavy applications of gypsum (2 to 3 tons per acre) are necessary.

The cost of operations directly connected with the leaching operations ranged between \$90 and \$92 per acre or about 15 to 16 percent of the total cost of reclamation and development.

U. Calif., Los Angeles, Calif.

Hill, R. A. LEACHING REQUIREMENTS IN IRRIGATION. J. Irrig. and Drain. Div., ASCE 87(IR 1): 1-5. Mar. 1961.

One of the primary purposes of leaching is the removal of prior accumulations of salt to restore the productivity of land. This requires that large volumes of water be applied on the land surface; that the water be caused to percolate through the soil; and that the percolate, which has picked up the accumulate salt, be disposed of as drainage effluent.

The second important function of leaching is the maintenance of a salt balance in the root zone of irrigated lands. This requires the passage of enough water through the soil to carry away the salts that are brought to the land in the water applied for irrigation.

The third function of leaching is to control the salinity of the soil solution from which the plants derive water. This function is not recognized generally, but the leaching requirements is necessarily greater where strongly saline waters are used than where moderately saline waters are available for irrigation of crops.

Leeds, Hill, and Jewett, Inc., Los Angeles, Calif.

Ehlig, C. F. EFFECTS OF SALINITY ON FOUR VARIETIES OF TABLE GRAPES GROWN IN SAND CULTURE. Amer. Soc. Hort. Sci. 76: 323-331. 1960.

Black Rose, Cardinal, Perlette, and Thompson Seedless varieties of grapes were grown in sand culture with a nutrient solution to which was added 1-atm. mixed chlorides, 2-atm. mixed chlorides, 2-atm.  $\text{CaCl}_2$ , 2-atm.  $\text{Na}_2\text{SO}_4$ , or no salt. Chloride accumulation from high chloride treatments caused burn on leaf blades of all varieties. Injury developed very rapidly at temperatures above  $100^\circ\text{F}$ ., but very slowly at temperatures below  $90^\circ\text{F}$ . Treatments containing large amounts of calcium in addition to chloride were much more injurious than the  $\text{NaCl}$  treatment. Black Rose and Cardinal were much more sensitive to chloride than Perlette and Thompson Seedless because they accumulated chloride two to three times faster. All varieties were injured by chloride earlier with each succeeding season. High concentrations of sulfate in the  $\text{Na}_2\text{SO}_4$  treatment caused magnesium deficiency symptoms on all varieties.

Salinity reduced vine growth but growth was adequate on all treatments where chloride injury did not cause vines to deteriorate. Excessive growth caused lower fruit production on the non-saline treatment than on the saline treatments. Yields of all varieties on the 2-atm. salt treatments averaged about 30 to 45 pounds per vine except for Black Rose and Cardinal on the mixed chloride and  $\text{CaCl}_2$  treatments where vines died or nearly died.

U.S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Chang, C. W. EFFECTS OF SALINE IRRIGATION WATER AND EXCHANGEABLE SODIUM ON SOIL PROPERTIES AND GROWTH OF ALFALFA. Soil Sci. 91: 29-37. 1961.

Effects produced by various levels of exchangeable-sodium percentage, and total soluble salts, acting together and separately, on properties of Gila 1 and alfalfa growth were determined in the greenhouse. The saline irrigation waters with salt concentrations ranging from 400 to 9,000 p.p.m. were used on Gila 1 that had been adjusted to four levels of exchangeable sodium.

Saline irrigation water containing 3,000 p.p.m. dissolved salts did not depress alfalfa yield unless the sodium content of the soil or of the irrigation water was high.

The relationship of exchangeable-sodium percentage, ESP, and soluble salts in the irrigation water to plant growth varied with the levels of ESP in the soil and soluble salts in water. At intermediate ESP and soluble-salt levels, the effect of ESP and salt was additive. At high ESP levels, the yield tended to increase with moderate increase in soluble salt in the irrigation water up to 3,000 p.p.m. Possible roles played by soluble salts in the soil are suggested.

The effects of soil salinity on germination and emergence was investigated as an aid in interpreting the relative high salt tolerance of alfalfa under greenhouse conditions. Excessive salt had a greater depressing effect on germination and emergence than on the yield.

Saline irrigation water caused either increase (alkalization) or decrease (dealkalization) in ESP, depending upon the initial ESP of the soil, and the composition of irrigation water. As a factor affecting sodium adsorption, the ratio of  $\text{Na}/\text{Ca}$  is more important than the total amount of  $\text{Na}$  or  $\text{Ca}$  in the irrigation water.

The relation of yield to either ESP or salt concentration in absence of the other was almost linear. When either ESP or soluble salt concentration was high, the relation of yield to the other factor was no longer linear. The departure from a linear relation when both excess ESP and salt are present may hinder the demonstration of linear correlation between crop yield and a single-value soil property, such as ESP or soluble salts. Results from statistical analysis appear to confirm this line of reasoning.



Alfalfa yields correlate most satisfactorily with an integrated-single-value expression (modified pL) consisting of twice the pH of saturated soil paste minus the negative log of the electrical conductivity of saturation extract of the soil.

The correlation of alfalfa yield to other soil properties or plant composition, and the correlation between the chemical composition of soil and tissue extracts were discussed.

After alfalfa had been grown with saline irrigation waters, the relation between exchangeable and soluble sodium in these soils was examined. Following the growth of alfalfa, the exchangeable-sodium percentage was closely related to the ratio of soluble sodium to calcium (Na/Ca), the soluble-sodium percentage (SSP), and especially sodium adsorption ratio (SAR). When the Na/Ca ratio SSP, or SAR of saturation extracts of the soil reached or exceeded 3, 65, and 18, respectively, they indicated an ESP level equal to or above 25, which is the point shown to affect crop yield.

The relation between ESP and soluble Na/Ca ratio was investigated under laboratory conditions. It was found that Na/Ca ratio in the soil solution, not that of the added salt solution, was correlated with sodium adsorption.

N. Mex. Agr. Expt. Sta., State College, N. Mex.

### Cover Crops and Green Manure Crops

Ram, D. N., and Zwerman, P. J. RETURNS FROM DOMESTIC RYEGRASS COVER CROP. J. Soil and Water Conserv. 16: 18-20. 1961.

Roots and tops of domestic ryegrass used as a cover crop yielded 1 ton of dry matter when the crop was heavily fertilized and only one-half this amount under moderate fertilization. Depending upon the date of turning under, the dry matter yield could be increased more than twofold. Nitrogen, phosphorus, and potash content of the dry matter were more than doubled by heavy applications of fertilizer.

Jr. Author, Col. Agr., Cornell U., Ithaca, N. Y.

### Climatic Influences

Hershfield, D. M. RAINFALL FREQUENCY ATLAS OF THE UNITED STATES: FOR DURATIONS FROM 30 MINUTES TO 24 HOURS AND RETURN PERIODS FROM 1 TO 100 YEARS. U. S. Dept. Comm., Weather Bur. Tech. Paper 40, 115 pp. 1961.

This is a convenient summary of empirical relationships, working guides, and maps, useful in practical problems requiring rainfall frequency data. It is an outgrowth of several previous Weather Bureau publications and contains and expansion and generalization of the ideas and results in earlier papers. This work has been supported and financed by the Soil Conservation Service, U. S. Department of Agriculture, to provide material for use in developing planning and design criteria for the Watershed Protection and Flood Prevention program.

The paper is divided into two parts. The first part presents the rainfall analyses. Included are measures of the quality of the various relationships, comparisons with previous works of a similar nature, numerical examples, discussions of the limitations of the results, transformation from point to areal frequency, and seasonal variation. The second part presents 49 rainfall frequency maps based on a comprehensive and integrated collection of up-to-date statistics, several related maps, and seasonal variation diagrams. The rainfall frequency

(isopluvial) maps are for selected durations from 30 minutes to 24 hours and return periods from 1 to 100 years.

\$1.75 from Supt. of Doc., U. S. Govt. Printing Off., Washington 25, D. C.

Hershfield, D. M., and Wilson, W. T. A COMPARISON OF EXTREME RAINFALL DEPTHS FROM TROPICAL AND NONTROPICAL STORMS. J. Geophysical Res. 65: 959-982. 1960.

It has been suggested that tropical storms are significantly different from other storms with respect to frequency and other hydrologic characteristics of extreme rainfall. Routine frequency analyses of storms of tropical origin were compared with storms not of tropical origin. The region of study extended from Texas eastward to the Atlantic Coast and northward into Maine.

It was concluded that in the following important respects, the extreme rainfall associated with tropical storms does not stand out as being significantly different from extreme rainfall associated with other types of storms: (1) Frequency distribution of annual maximum for durations of 10 minutes to 168 hours; (2) shape of area-depth curve up to 5000 square miles; (3) time distribution within the largest 24-hour rainfalls; and (4) time sequence or mass curves of these rainfalls. Tables, maps, and graphs.

Hydrol. Serv. Div., U. S. Weather Bur., Washington, D. C.

Hershfield, D. M., and Kohler, M. A. AN EMPIRICAL APPRAISAL OF THE GUMBEL EXTREME-VALUE PROCEDURE. J. Geophysical Res. 65: 1737-1746. 1960.

The predictive value of the widely used Fisher-Tippett type I distribution, when fitted to rainfall data by the Gumbel method, is appraised. Thousands of station years of rainfall data were analyzed in several ways in evaluating the Gumbel procedure. The results provide evidence of the acceptability of the Gumbel procedure for predicting the probability of occurrence of the extreme values of rainfall. Tables (including probability) and graphs.

Hydrol. Serv. Div., U. S. Weather Bur., Washington, D. C.

Burchinal, J. C., and Dickerson, W. H. RAINFALL PROBABILITY AND ITS APPLICATIONS. West Va. U. Agr. Expt. Sta. B. 454T, 26 pp. 1961.

Weather data, including temperature and precipitation records, have been entered on IBM punch cards for 24 West Virginia Stations beginning with January 1, 1926. This work was done in cooperation with the United States Weather Bureau and the Northeast Regional Project NE-35, "Application of Climatology to Northeastern Agriculture."

One of the possibilities for utilizing the precipitation data is for the preparation of rainfall probability or frequency estimates. Such estimates have been illustrated by computations for weekly, monthly, and seasonal rainfall amounts. Three methods of determining frequency curves have been used - the equation proposed by Kimball, the log-probability method, and the incomplete gamma distribution. Some possible applications illustrating the use of frequency curves in engineering and agriculture are suggested.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Gomm, F. B. A MODIFICATION OF THE STANDARD WEATHER BUREAU RAIN GAGE FOR SUMMER AND WINTER USE. Amer. Meteorological Soc. 42(5): 311-313. 1961.

A modified collection unit for the standard Weather Bureau-type rain gage is described and illustrated. The unit, consisting of a polyethylene bottle, rubber stopper, vent tube, and adapter funnel, replaces the metal collection tube of the standard gage.

In a laboratory test, evaporation from the modified system was not great enough in a 30-day period to measure with a standard measuring tube. Field tests showed the described unit superior to the standard collection unit and equal to the standard unit with a 0.20-inch oil film in the reduction of evaporation. The described unit, which eliminates recharging with oil or antifreeze after each reading, has been in field use for 2 years without damage from freezing.

CRD, ARS, USDA, Bozeman, Mont.

Caro-Costas, R., and Vicente-Chandler, J. EFFECTS OF SEASON, NITROGEN FERTILIZATION, AND MANAGEMENT ON THE PRODUCTIVITY OF FIVE TROPICAL GRASSES. Agron. J. 53: 59. 1961.

The effects of season of the year, nitrogen fertilization, and harvesting by cutting compared to simulated grazing on the productivity of guinea (Panicum maximum), napier (Pennisetum purpureum), para (Panicum purpurascens), pangola (Digitaria decumbens), and molasses (Melinis minutiflora) grasses under humid tropical conditions were determined.

Mean annual temperature was about 75° F. with a seasonal variation of less than 10° F., and the annual rainfall averaged 83 inches. The soil, a deep, well-drained, red, acid latosol, was limed to pH 6.5 and all plots provided with an abundance of phosphorus and potash.

TABLE 1.--Effects of N fertilization and 2 methods of harvesting on yields and protein contents of 5 tropical grasses over a 2-year period.

Grass	Annual N applied, lb. per acre	Harvested by <u>cutting every 60 days</u>		Harvested by simulated <u>grazing every 40 days</u>	
		Dry forage, lb. per acre yearly	Protein, %	Dry forage, lb. per acre yearly	Protein, %
Para	0	8,742	6.4	6,693	8.2
	200	19,638	6.6	12,179	8.8
	400	24,025	8.0	15,694	10.0
	800	26,054	9.9	16,479	12.9
Guinea	0	9,675	7.7	8,821	8.7
	200	19,645	7.6	15,176	8.8
	400	23,002	7.8	19,330	9.4
	800	28,180	10.0	26,696	11.4
Napier	0	13,308	7.4	7,579	10.5
	200	21,395	6.9	11,591	10.6
	400	25,214	7.5	14,953	11.6
	800	33,284	8.7	19,415	12.8



TABLE 1.--Effects of N fertilization and 2 methods of harvesting on yields and protein contents of 5 tropical grasses over a 2-year period--Cont.

Grass	Annual N applied, lb. per acre	Harvested by <u>cutting every 60 days</u>		Harvested by simulated <u>grazing every 40 days</u>	
		Dry forage, lb. per acre yearly	Protein, %	Dry forage, lb. per acre yearly	Protein, %
Pangola	0	8,614	6.4	6,981	7.0
	200	18,106	6.9	11,287	8.7
	400	23,707	7.9	16,332	10.3
	800	26,686	10.9	18,362	12.0
Molasses	0	9,275	7.3	6,479	7.9
	200	13,271	8.1	8,880	8.4
	400	13,246	9.8	10,647	10.1
	800	11,937	11.2	8,863	11.8

SWCRD, ARS, USDA, Rio Predras, Puerto Rico.

Schaal, L. A., Newman, J. E., and Emerson, F. H. RISKS OF FREEZING TEMPERATURES--SPRING AND FALL IN INDIANA. Purdue U. Agr. Expt. Sta. Res. B. 721, 20 pp. 1961.

Freeze-free season length and specific freeze date probabilities have been developed for Indiana. The freeze risk for any Indiana location and date can be estimated using the probability tables in this publication. These probabilities were computed from U.S. Weather Bureau records of 30 years.

Since ground level temperatures are frequently lower than air temperatures obtained 5 feet above the ground, plants may be subjected to freezing temperatures even when the air temperature is several degrees above freezing. Ground level temperatures vary with terrain and soil type.

Freeze injury to plants depends upon the variety and species of the plant as well as the exposure to freezing temperatures. The frost hardiness of fruit trees, ornamentals, vegetable crops, and commercial crops are listed. Other factors pertaining to damaging freeze probabilities are discussed.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Willis, W. O., Carlson, C. W., Alessi, J., and Haas, H. J. DEPTH OF FREEZING AND SPRING RUN-OFF AS RELATED TO FALL SOIL-MOISTURE LEVEL. Canad. J. Soil Sci. 41: 115-123. 1961.

Studies were conducted at Mandan, N. Dak., to evaluate effects of soil moisture level in the fall and snow depth on depth of freezing and spring run-off. Results showed that soil, which was dry in the fall, froze faster and deeper than a wet soil. Insulative effects of snow increased with snow depth. In the spring, a dry profile thawed upward to the surface while a wet soil thawed both upward to and downward from the soil surface. Run-off in the spring was less from dry soil. Completion of run-off coincided with frost removal from the dry plots but thawing was not complete in wet soil until about 10 days after run-off had ceased. Time of run-off completion was the same for wet or dry soils.

SWCRD, ARS, USDA, Mandan, N. Dak.

Havens, A. V., and McGuire, J. K. THE CLIMATE OF THE NORTHEAST: SPRING AND FALL LOW-TEMPERATURE PROBABILITIES. N. J. Agr. Expt. Sta. B. 801, 32 pp. 1961.

Useful information on the last occurrence in spring and the first occurrence in fall of critically low temperatures over the Northeastern United States is given.

These "freeze" occurrences affect many economic interests, but none, is more vitally affected than agriculture. The information is intended to advise farmers, orchardists, and commercial and home gardeners on the risks to be expected from certain specified low temperatures.

N. J. Agr. Expt. Sta., Rutgers - The State U., New Brunswick, N. J.

Junge, C. E. SULFUR IN THE ATMOSPHERE. J. Geophysical Res. 65: 227-237. 1960.

In unpolluted areas, sulfur occurs primarily in three compounds,  $\text{SO}_4$  in aerosols and  $\text{SO}_2$  and  $\text{H}_2\text{S}$  as gas. Sources of  $\text{SO}_4$  are the ocean, the soil, and the oxidation of the gaseous compounds. A considerable fraction of the  $\text{SO}_2$  is of anthropogenic origin. As measurements in polluted and unpolluted areas indicate, most of the  $\text{H}_2\text{S}$  seems to be natural. In unpolluted air in the northeastern part of the United States, both gases have approximately equal concentrations.

Estimates of the sulfur budget of the global atmosphere, excluding the  $\text{SO}_4$  in sea salt particles, indicate that 30 percent is of anthropogenic origin. Measurements of the chemical composition of Greenland ice back to the year 1915 are presented. The measurements show that the concentration of  $\text{SO}_4$  is much higher than that of other soluble constituents, but it has not increased since 1915 as much as one would expect if it were of industrial origin. It is concluded that industrial sulfur is removed from the atmosphere before it spreads to polar regions. This is consistent with estimates of the residence time of about 5 days for  $\text{SO}_2$  and about 40 days for total sulfur.

Conway showed that more  $\text{SO}_2$  enters the oceans with river water than can be accounted for by the weathering of rocks and sediments on land and that the excess must come from the atmosphere. He assumes a closed sulfur cycle and suggests that this sulfur must return to the atmosphere as  $\text{H}_2\text{S}$ , produced in the shelf areas of the oceans. In view of the considerable amounts of industrial sulfur, it is possible that the global sulfur cycle is not closed and that most of the excess sulfur in river waters is of anthropogenic origin and will stay in the ocean.

Geophysics Res. Dir., Air Force Cambridge Res. Cent., Bedford, Mass.

### Surface Soil Removal

Grunes, D. L., Boawn, L. C., Carlson, C. W., and Viets, F. G., Jr. ZINC DEFICIENCY OF CORN AND POTATOES AS RELATED TO SOIL AND PLANT ANALYSES. Agron. J. 53: 68-71. 1961.

Marked Zn deficiencies of corn and mild Zn deficiencies of potatoes, occurred in field experiments where the surface soil was removed to aid gravity irrigation. The exposed subsoils were low in acid-soluble Zn. Zn was also low in tissues of plants grown on these sites.

Zn deficiency was cured by  $\text{ZnSO}_4$  either applied to the soil, or sprayed on the plants. Manure applications, which contained some Zn, also alleviated the Zn deficiency.

SWCRS, ARS, USDA, Mandan, N. Dak.

## Mulching

Nickerson, R. MULCH PROTECTION FOR VEGETABLES. S. Dak. Farm and Home Res. 9(3): 18-22. 1961.

The two greatest effects of a good mulch, are soil moisture conservation and weed control. Mulches also help reduce soil erosion, soil compaction, and plant disease; influence soil temperature and plant food availability; and improve soil structure and plant quality.

Mulches can be divided into natural or organic and processed or synthetic. Organic mulches include sawdust, leaves, hay or straw, grain hulls, grass clippings, ground corn cobs, compost, and decomposed manure. Paper and polyethylene plastic are examples of synthetic mulches. While each type has its advantages and disadvantages, the goal of each is to increase yields.

In a study of black polyethylene plastic the following advantages were obtained: (1) Increased yield of most vegetables, except tomatoes; (2) gave results as good as, or better than, common organic mulches on most crops; (3) eliminated a large amount of time and work with weed control; and (4) promoted earliness in many crops.

Black plastic costs about 7 cents per square yard. Yearly costs could be reduced by reusing the plastic. The cost is further equalized when the time spent on weed control, the increased and earlier yields, better quality, and more attractive fruit are considered.

S. Dak. State Col., Agr. Expt. Sta., Brookings, S. Dak.

Parks, W. L., Chapman, E. J., and Safley, L. M. EVALUATE PAPER AND PLASTIC MULCHES IN TOBACCO PRODUCTION. Tenn. Farm and Home Sci. 37: 8-9. March 1961.

Paper and plastic mulches were evaluated for 2 years in the production of burley and dark tobacco. The experiments on burley tobacco were conducted on Maury soil at the Middle Tennessee Experiment Station; those on dark tobacco were conducted on Dickson and Mountview soils at the Highland Rim Experiment station.

The mulches should reduce moisture loss by evaporation, increase soil temperature, control weeds, and practically eliminate soil puddling and compaction from heavy rains. They may eliminate the need for all cultivation and hoeing operations.

The yield and dollar per acre value data show no significant differences among the treatments in terms of acre yield or acre dollar value. This would indicate that applying the paper and plastic mulches, which eliminates plowing and hoeing, produces about as much tobacco with a market value about equal to that obtained under common cultivation procedures.

With present prices, it seems that using paper or plastic mulches does not pay. The paper and plastic costs more than cultivation.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Bement, R. E., Hervey, D. F., Everson, A. C., and Hylton, L. O., Jr. USE OF ASPHALT-EMULSION MULCHES TO HASTEN GRASS-SEEDLING ESTABLISHMENT. J. Range Mangt. 14: 102-109. 1961.

The effect of two asphalt-emulsion mulches on the establishment of blue grama, sideoats grama, and Sudangrass was studied at Central Plains Experimental Range near Fort Collins, Colo. Results were interpreted in terms of soil moisture, soil temperature, plant emergence, plant growth, and plant survival. The authors conclude: (1) In one-season exploratory tests, emergence and development of blue grama plants were hastened by the use of an asphalt mulch; (2) the



net effect of an asphalt mulch on seedling establishment varied considerably with the kind of asphalt used and the species planted; (3) seed and plant reactions to asphalt mulching should be carefully checked before an asphalt mulch is recommended for establishment of any species; (4) soil moisture at the 1-inch depth was maintained for a longer period under an asphalt mulch than in the check; (5) soil temperatures from the 1-inch depth through the 12-inch depth were higher under an asphalt mulch than in the check; (6) the rapid-setting-emulsion asphalt mulch held moisture and increased temperature for a longer period than did the slow-setting-emulsion asphalt mulch; and (7) the moisture-holding ability of the asphalt mulch was reduced by high-intensity rainstorms or hailstorms which tended to break up the film.

CRD, ARS, USDA, Fort Collins, Colo.

Richardson, E. C., and Diseker, E. G. ROADSIDE MULCHES. *Crops and Soils* 13(5): 16. 1961.

One of the aids in creating soil conditions suitable for rapid cover growth is the use of mulches when seeding. Most mulches will greatly improve grass stands on sloping roadbanks. A recent study in the Coosa Watershed area of northwest Georgia compared six different mulches.

The mulch treatments were grain and pine straws, sawdust, plastics, jute bagging, and water latex. These mulches were used from 1957 to 1959 to cover spring plantings of weeping lovegrass and common Bermudagrass; and in the fall of 1958 and 1959 and the spring of 1959 and 1960, for seedings of crown vetch. High rates of fertilization were used on all plantings.

In general, all the mulches improved seed germination and stands by conserving moisture, holding seed and fertilizer in place, and insulating against frost. They were more beneficial for the slowly growing fall-seeded species than the more rapidly developing fall- and spring-seeded species.

Pine straws and grain straws were the most economical of the mulches and insulated grass seedlings against frost damage. Straw formed an interwoven cover which resisted raindrop impact and rill and sheet erosion. Two tons of straw, evenly spread, resulted in good stands; but 4 tons were too heavy and smothered many seedlings.

Sawdust, applied in a thin layer and worked in the soil, conditioned clay soils and aided seedling emergence. But, sawdust did not form a strong cohesive cover and was severely eroded by rain and allowed seedlings to be damaged by frost.

Clear plastic mulch resulted in quick germination and early stands in spring. But, as soon as the stands were established, all plastic had to be removed, or high temperatures during sunny days caused scalding of plants. Seedlings developed under plastic became chlorotic, spindly, and weak, if cover was left too long after germination.

Many of the fall-seeded plants under plastic were lost as the result of winter frost. Many of the plastic-covered seedlings from spring-seeded crown vetch were washed out by summer rains.

Jute bagging provided more protection against sheet erosion than any of the other mulches tested. It did not insulate against frost as well as grain straw. Jute bagging apparently could be used best in flow channels.

Water latex, a new spray material, looked promising, but only limited test data are available on it. Sprayed on the soil surface at 50 to 100 gallon rates per acre, water latex forms a black rubberlike film which resists erosion.

Abruzzi rye looks very promising as a companion crop for slowly developing fall-seeded species such as crop vetch. Seeded at 1 bushel per acre, rye quickly produced a protective cover which resisted erosion and reduced frost damage. When mature, the rye remained on the surface for 2 years or more and provided an excellent mulch in which to seed permanent species.

Where no mulch was applied on slopes flatter than 2 to 1, stands were almost as good as on the mulched plots. This was especially true if rains of low intensity followed seeding. But if seeding without mulch was followed by heavy rains, or severe frost in the case of fall seeding, only a few plants survived. In many cases, frost action moved all of the seedlings to the bottom of the road bank.

SWCRD, ARS, USDA, Coosa Watershed Project, Cartersville, Ga.

## PLANT MANAGEMENT

### Pasture and Haylands

Elder, W. C., and Murphy, H. F. PRODUCTION CHARACTERISTICS OF OKLAHOMA FORAGES: GRAZING CHARACTERISTICS AND CLIPPING RESPONSES OF BERMUDAGRASS. Okla. Agr. Expt. Sta. B. B-577, 23 pp. 1961.

Common bermudagrass and Hop clover pastures at the Heavener Station, Okla., when fertilized with 200 pounds of 0-20-0 annually and 100 pounds of muriate potash every third year produced a 10-year average of 253 pounds of animal gain per acre from 1-year old beef steers.

Comparative nonfertilized pastures produced 167 pounds per acre. The high production from nonfertilized pastures was possible because the grazing test started on a thriving pasture that had been fertilized and pastured for several years previous to the test period.

Increased gain per acre for the fertilized pasture was due to higher carrying capacity and not to higher individual gain.

Steer gains were high in the spring months but very low in summer. Seventy percent of the seasonal gain occurred before July 1. The average carrying capacity for fertilized pastures was 0.9 acre per steer, and 1.3 acres for nonfertilized pastures.

Steers on bermudagrass pastures fed 5 pounds of ground sorghum grain daily for 123 days, July to November, gained 91 pounds over animals not receiving the grain. The extra gain did not finish the animals for slaughter.

Calves weighing 100 to 150 pounds each from grade Hereford cows grazing Bermudagrass-Hop clover pastures gained 1.5 pounds daily or 300 pounds for 200 days. These gains were more uniform during the season than were the gains with the steers. Calf gains were low in October.

On the Stillwater Station, 1 pound of nitrogen applied on Common bermudagrass growing on good soils produced 1.5 pounds of beef over nonfertilized treated pastures. Increased gains on grade Hereford heifers were from higher carrying capacity and not higher gain per animal.

Nitrogen application in the summer months made it difficult to maintain proper carrying capacity.

A pasture of Midland bermudagrass-Ladino clover over-seeded with rye in the fall produced more than 900 pounds of animal gain per acre. The carrying capacity for 8 months grazing was 3 to 4 animals per acre.

Midland bermudagrass irrigated and treated with 200 to 400 pounds of nitrogen per acre produced 7,000 to 8,000 pounds of dry matter per acre in 120 days.

Nine-month to one-year old steers grazing dry bermudagrass in the winter months and fed 2 pounds of 40 percent protein supplement daily made gains from 0.2 to 0.70 pounds per day.

Small grains could not be established in bermudagrass in the fall in time for enough fall growth to provide winter grazing. Spring growth depended upon the amount of nitrogen available.

Vetch and Crimson clover over-seeded on Greenfield bermudagrass under good fertility and moisture conditions produced total forage comparable to 100 pounds of nitrogen per acre.

The addition of vetch and Crimson clover residue to the soil stimulated bermudagrass growth but Hop clover residue did not affect grass growth.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Caro-Costas, R., and Vicente-Chandler, J. EFFECTS OF TWO CUTTING HEIGHTS ON YIELDS OF FIVE TROPICAL GRASSES. J. Agr. U. Puerto Rico. 45(1): 46-49. 1961.

The effect of two cutting heights (low, 0-3 inches; and high, 7-10 inches) on the productivity of well-fertilized Napier grass (Pennisetum purpureum), Guinea grass (Panicum maximum), Pangola grass (Digitaria decumbens), molasses grass (Melinis minutiflora), and Para grass (Panicum purpurascens) mixed with some Carib grass (Eriochloa polystachya), were studied under typical conditions in the humid mountains of Puerto Rico.

All plots were limed to about pH 6.0 and received 3,000 pounds of 14-4-10 fertilizer per acre yearly in six equal applications.

TABLE 1.--The effect of two cutting heights on annual yields and protein content of 5 well-fertilized tropical grasses growing in the humid mountains of Puerto Rico, and harvested every 2 months over a 2-year period, 1958-59

Grass and cutting height	Yields of green forage per acre yearly			Yields of dry forage per acre yearly <sup>2</sup>	Protein <sup>3</sup>
	1958	1959	Average of 2 years <sup>1</sup>		
	<u>Lb.</u>	<u>Lb.</u>	<u>Lb.</u>	<u>Lb.</u>	<u>Percent</u>
Molasses					
high	67,802	53,973	60,887	12,056 (19.8)	13.5
low	33,959	5,104	19,531	3,945 (20.2)	13.5
Pangola					
high	72,993	86,507	79,750	19,937 (25.0)	11.5
low	126,440	121,829	124,134	29,296 (23.6)	12.1
Para					
high	89,030	81,142	85,086	19,740 (23.2)	11.0
low	122,612	88,740	105,676	24,728 (23.4)	11.0
Guinea					
high	105,357	102,543	102,950	25,223 (24.5)	10.2
low	112,346	119,119	115,732	24,651 (21.3)	11.1
Napier					
high	147,233	103,592	125,412	23,201 (18.5)	10.3
low	191,545	125,280	158,412	27,880 (17.6)	9.2

<sup>1</sup> Asterisks indicate differences are statistically highly significant (0.01 level).

<sup>2</sup> Numbers in parentheses indicate percentage of dry matter.

<sup>3</sup> On a dry-weight basis.

SWCRD, ARS, USDA, and U. Puerto Rico, Rio Predias, Puerto Rico.



Cook, C. W. SEEDING RESPONSE AND SOIL CHARACTERISTICS ON ADJACENT SAGEBRUSH AND DESERT MOLLY SOILS. J. Range Mangt. 14: 134-138. 1961.

Vegetation of the shadscale and sagebrush zones in the Great Basin area commonly display a mosaic pattern. Vegetation of the sagebrush zone in northwestern Utah appears to be a homogeneous expanse of sagebrush (Artemisia tridentata) but close observation reveals the presence of islands of dense halogeton (Halogeton glomeratus) and a few desert molly (Kochia vestita) plants without sagebrush. Vestiges of root crowns indicate that these islands once supported mainly desert molly with an occasional winterfat (Eurotia lanata) plant.

Seeding experiments on these areas in northwestern Utah showed that areas formerly occupied by sagebrush supported dense stands of Russian thistle with a fair stand of crested wheatgrass following plowing and planting. The areas formerly occupied by desert molly and winterfat supported dense stands of halogeton with an extremely poor stand of grass following tillage and seeding.

These differential responses in areas lying adjacent to one another led to a study of some of the soil and moisture conditions favoring growth of various plant species in the two vegetation types. The study was conducted during 1957 and 1958. The precipitation was 12.6 inches during 1957 and 10.2 inches during 1958.

The sagebrush soils had a somewhat better soil structure than desert molly soils and as a result had a lower bulk density and more rapid water infiltration. Desert molly soils were higher in total soluble salts, exchangeable sodium and saturation extract conductivity. Sagebrush soils were considered better for seeding crested wheatgrass from the standpoint of salinity and alkalinity.

It was concluded that Russian thistle will not grow in saline-alkali soils of the nature of the desert molly soils observed in this investigation. Russian thistle successfully competed with halogeton in non-saline soils where the moisture supply was 10 inches or more annually. It was concluded that crested wheatgrass was not more susceptible to competition from halogeton than Russian thistle, but did not thrive on saline-alkali soils where halogeton predominated.

Utah Agr. Expt. Sta., Logan, Utah.

Peters, R. A. LEGUME ESTABLISHMENT AS RELATED TO THE PRESENCE OR ABSENCE OF AN OAT COMPANION CROP. Agron. J. 53: 195-198. 1961.

When measured at the time the oats were removed for silage, legume yields were lowest when seeded with oats. Recovery during a favorable year (1959) was rapid for alfalfa, red clover, and Ladino clover. Yields of birdsfoot trefoil remained depressed. During a dry year (1957) alfalfa regrowth was satisfactory following seeding competition with weeds but not with oats. It was concluded that oats frequently will be much more competitive than the weed growth which will flourish in their absence.

Storrs Agr. Expt. Sta., Storrs, Conn.

Longhouse, A. D., ed. HAY CONDITIONERS IN THE NORTHEASTERN UNITED STATES. W. Va. U. Agr. Expt. Sta. B. 449, (Northeast Reg. Res. Proj.) 32 pp. 1960.

The following conclusions were drawn from the combined cooperative research of the several states in the Northeast.

1. Hay conditioning, whether through the use of a crusher, crimper, or flail harvester, can significantly reduce the required field drying time of forage crops, in some cases by 30 percent or more. Indications are that conditioning may also reduce drying time in forced-air drying systems.

2. In general, uniform crushing will result in more rapid drying than will uniform crimping. This advantage may be partially or completely offset by the fact that it is considerably more difficult to crush hay uniformly than to crimp it uniformly.

3. Conditioning has a greater effect on legumes than on grasses; the thicker the stem, the greater the effect.

4. In the ordinary hay curing process, a tedder is of little or no value. It does help remove free water after a rain.

5. In grasses, fluffing is of no importance, but adequate fluffing is advantageous with legumes.

6. The lacerating action of a flail harvester, without windrowing, used for cutting forage for hay produces a more rapid drying rate than can be obtained by the other types of conditioners. Dry matter losses are also greater in some systems; tests have indicated losses to be in the range of 1/4 to 1/3 greater than with crushers or crimpers, when used on legumes in a baled-hay system.

7. A self-propelled windrower may be desirable from the standpoint of increased operational efficiency, but the windrowing of hay immediately after conditioning slows down the drying rate.

8. The purpose of a hay conditioner is to reduce the amount of time hay must be left in the field. From this standpoint, there is little difference among the various types of conditioners; each will permit harvesting hay, as field cured hay, one day earlier than unconditioned hay, under average haymaking conditions throughout most of the Northeast.

9. Field cured hay, conditioned or not, remains subject to the rather severe shattering losses to which completely field cured hay, especially of the legume varieties, is always susceptible.

W. Va. Agr. Expt. Sta., Morgantown, W. Va.

Person, N. K., Jr., and Sorenson, J. W., Jr. A COMPARISON OF DIFFERENT METHODS OF FIELD CURING ALFALFA AND SUDANGRASS.

Tex. Agr. Expt. Sta. Prog. Rpt. 2185, 4 pp. 1961.

Tests were conducted during the spring and summer of 1960 in the Brazos River Valley near College Station, Tex., to determine the effects of different hay-making methods and equipment on field-curing time. Part of the results are summarized in the following table.

TABLE --Number of hours required to field Cure Alfalfa and Sudangrass to a moisture content of 50 and 25 percent (wet basis)<sup>1</sup>

Treatments	Hours required to reduce moisture content to:			
	50 percent (wet basis)		25 percent (wet basis)	
	Alfalfa	Sudangrass	Alfalfa	Sudangrass
1. Mow--cure in swath	5.5	50.0	39.5	54+ <sup>2</sup>
2. Mow--windrow immediately--cure in windrow	23.3		50.7	
3. Mow--cure in swath to 50 percent--windrow--cure in windrow			40.8	
4. Mow--crush--cure in swath	3.7	5.9	25.2	28.7
5. Mow--crush--windrow immediately--cure in windrow	6.6		37.9	
6. Mow--crush--cure to 50 percent--windrow--cure in windrow			35.8	

TABLE .--Number of hours required to field Cure Alfalfa and Sundangrass to a moisture content of 50 and 25 percent (wet basis)<sup>1</sup>--Cont.

Treatments	Hours required to reduce moisture content to:			
	50 percent (wet basis)		25 percent (wet basis)	
	Alfalfa	Sudangrass	Alfalfa	Sudangrass
7. Mow--windrow immediately--crush--cure in windrow	5.7		25.7	
8. Mow--crimp--cure in swath		6.6		28.3
9. Cut with flail harvester--cure in swath		24.4		31.0

<sup>1</sup> Alfalfa and Sudangrass were harvested during May and June, respectively.

<sup>2</sup> Test was ended after sample was in field for 54 hours. Moisture content after 54 hours was 45 percent.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Beaty, E. R., Hayes, D. D., and McCreery, R. A. COMPARISON OF COASTAL AND COMMON BERMUDAGRASS ON A SHALLOW DROUGHTY SOIL. J. Range Mangt. 14: 92-94. 1961.

Results from a 2-year comparison of Coastal and common bermudagrasses grown at 10 fertility levels on a shallow, eroded and droughty soil (Montevallo shaley sil) in the Limestone Valley and Upland soil province in Georgia permitted the following conclusions.

Coastal bermudagrass outyielded common bermudagrass by 206 percent at a low fertility level and 150 percent at a high fertility level. A major portion of the increased production was obtained during midsummer months when grass is usually in short supply.

Coastal bermudagrass maintains its high productivity on this extreme soil type.

Since there was little or no carry over of nitrogen, each year's production apparently must be fertilized independently of the previous year's fertilizer applications.

Fertilizer response of Coastal bermudagrass and soil reaction in the Limestone Valley was different than that reported from the Piedmont.

Ga. Agr. Expt. Sta., U. Ga., Col. Agr., Athens, Ga.

Curtis, B. C., Peier, D., and Schlehuber, A. M. EVALUATION OF WINTER OAT VARIETIES FOR HAY PRODUCTION. Okla. Agr. Expt. Sta. B. B-586. 11 pp. 1961.

Hay yield and quality studies were conducted on 10 winter oat varieties during the period 1958-1960 at Stillwater, Okla. Forkedeer and Bronco showed the best overall performance as hay types, both producing high yields of good quality hay. Cimarron produced the highest quality hay, but was consistently the lowest yielding variety. Because of the high stem content, the hay of Arkwin was considered to be of the lowest quality among the varieties tested.

Among all varieties, tiller number and plant height were found to be greatly influenced by climatic variations among the different years. Tiller number appeared to have no relationship to quantity of hay produced, and only when the



plants were extremely tall or short did plant height appear to be associated with yield. The extreme short stature of Cimarron probably accounts for its low yield performance.

Except for Cimarron, there appeared to be little association of varietal maturity and yield.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Hoveland, C. S. BAHIAGRASS FOR FORAGE IN ALABAMA. Ala. Agr. Expt. Sta. C. 140, 19 pp. 1961.

Bahiagrass, vigorous, warm season, perennial grass is a native of South America. Common Bahia, a low yielding grass, is not cold hardy enough for Alabama. Argentine Bahia is not cold hardy enough for northern Alabama. This variety, which is severely affected by ergot, starts growth later in the spring and is generally less productive than Pensacola even in southern Alabama.

An important advantage of Bahiagrass is that it can be established from seed. The seed should be planted on a well prepared seedbed at the rate of 15 pounds per acre. Seed yields of 200 to 300 pounds per acre are possible from well managed plantings.

In southern and central Alabama, Pensacola Bahia has given a forage yield comparable to Coastal Bermuda, but on wet soils it has been more productive. In northern Alabama it has been cold hardy and has given high annual yields but a much shorter productive season than in southern Alabama. Pensacola Bahia has been more successful than Coastal Bermuda under very low fertility. It is less suited to droughty soils than Coastal Bermuda.

Steer gains per acre on Pensacola Bahia have been higher than those obtained on common Bermuda, but lower than those on Coastal Bermuda. However, daily gains per animal have not been good. Satisfactory results have been obtained with brood cows and calves on Pensacola Bahia and clover or vetch. Growing a winter legume on Pensacola Bahia sod has extended the grazing season, increased forage yield, and improved animal performance. Much difficulty has been encountered in getting stands of winter legumes on the dense tough sod of Bahiagrass. Vetch, sod-seeded each fall, has been the most dependable legume.

Pensacola Bahia has failed to maintain a high level of lactation when used as the sole source of roughage for high-producing dairy cows.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

McCarty, M. K., and Sand, P. F. CHEMICAL WEED CONTROL IN SEEDLING ALFALFA III. EFFECT OF SOME HERBICIDES ON FIVE VARIETIES. Weeds 9(1): 14-19. 1961.

Five varieties of alfalfa, Buffalo, Grimm, Ladak, Ranger, and Vernal, were treated with low and heavy rates of 4-(2, 4-DB), dalapon, and combinations of the two. Few adverse effects were observed on the alfalfa except in 1958 when 4 lb/A 4-(2, 4-DB) plus 8 lb/A dalapon reduced stands of all varieties.

The weed control resulted in more hay on both harvest dates and sometimes an actual improvement in stand of the alfalfa.

The 4-(2, 4-DB) gave effective control of the broadleaved weeds at the rates used and the dalapon gave control of the grassy weeds. The combination of the two herbicides gave good control of all weeds present.

Reaction of the alfalfa varieties to weed elimination was the same whether accomplished by hand-weeding or herbicides.

Paper 990, Nebr. Agr. Expt. Sta., Lincoln, Nebr.

Shaudys, E. T., Sitterley, J. H., and Evans, R. P. LABOR, EQUIPMENT AND COSTS OF USING ROTATIONAL GRAZING AND GREEN CHOP PASTURE SYSTEMS IN OHIO. Ohio Agr. Expt. Sta. Res. B. 878, 20 pp. 1961.

Rotational grazing and green chopping are two methods employed by farmers to achieve greatest efficiency in utilizing forages during the growing season. Rotational grazing involves dividing a pasture area into a series of paddocks grazed in sequence. In a green chop system, the forage is harvested mechanically and hauled to the cows for feeding. More labor and capital are needed to use a green chopping system than a rotational grazing system. Offsetting this is the possibility of greater carrying capacities. Based on the acreage required per cow with each system and assuming similar yield, between a third and a fourth more area was needed to maintain the same size herd with rotational grazing than with green chopping. The added capital investment for rotational grazing was about \$150 per farm or \$5.10 per cow, whereas the additional capital investment for a green chop system averaged \$1,400 per farm or over \$30 per cow.

The annual added costs of typical rotational grazing systems ranged from \$2.37 to \$5.17 per cow. The added annual cost of typical green chop systems ranged from \$14.72 to \$16.94 per cow.

Farmers' experience indicated either system will work satisfactorily, but the added costs must be weighed against the possible returns. An increased annual cost of approximately \$12 per cow for a green chopping system over rotational grazing necessitates a sizeable increase in milk production to be profitable.

Higher returns from other crops and land values make it necessary to use pasture lands more profitably. The first step is to improve the productivity of the pasture or meadows. On many farms, greater returns will be obtained from dollars spent for improving the quality and yield of meadows than from installing more intensive pasturing systems. The second step is the use of a rotation grazing system. With a limited investment of labor and money in facilities, about one-fourth more cows can be carried with rotational grazing than with conventional grazing. A third step might be either a move to rationed grazing or the use of a green chopping system. Green chopping is demanding of labor and capital but will permit more intensive use of forage growth.

On the farms in this study, milk production was maintained at a nearly constant level. However, more cows freshened during late summer months. In general, farmers using a green chop system were able to maintain the production of milk with a smaller deviation from a monthly average of freshening than those using rotational grazing systems. It appears that more fall freshened cows were required to maintain constant production in herds using rotational grazing systems than when green chopping was used.

On an acreage basis, farm operators using a rotational grazing system were able to increase the carrying capacity about 25 percent over a conventional grazing system. This 25 percent increase in carrying capacity was obtained at an average annual increased cost of \$4.20 per acre. This would require an increase of 100 pounds of milk per acre to offset the cost over conventional grazing.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Hoglund, C. R., and Harrison, C. M. ECONOMICS OF ALTERNATIVE PASTURE SYSTEMS. Mich. Agr. Expt. Sta. Sp. B. 429, 30 pp. 1960.

The pasture systems used on 54 southern Michigan dairy farms were studied. The 5-year study included field-grazing used on 17 farms, strip-grazing on 9 farms, green-chopping on 20 farms, and storage-feeding on 8 farms. These farms were selected on the basis of those using distinct pasture systems and improved forage practices. Dairying was the major enterprise.

Forage crops accounted for 60 percent of the crops grown. Alfalfa-brome grass was the major crop produced for summer feed as well as for hay for the



barn-period. The 54 dairymen produced most of the feed grain fed and some wheat for sale.

Farmers who used strip-grazing or green-chopping made greater use of Sudan-grass for midseason feed. The cows in all four groups of farms were fed supplementary hay and silage during the pasture season.

The number of cows averaged about 33 for the farmers using field-grazing and strip-grazing, 38 for those green-chopping, and 51 for those feeding out of storage. The acreage of cropland averaged nearly the same for the first three groups and 50 acres more for those feeding out of storage.

Dairymen following a field-grazing system used nearly 1-1/3 acres of both first and second crop forage per cow during the pasture season. This included acres of all feed grazed or harvested and fed. A weighted average of both first and second crop forages used per cow was calculated for all systems. On the basis of 100 for field-grazing, it required 84 percent as many acres for strip-grazing, 67 percent for green-chopping, and 64 percent for storage-feeding.

Milk sales per cow per day averaged nearly the same for the farms with different pasture systems. Milk production per cow averaged 10,000 pounds or more per year for all farms in the study. Of the herds 52 were Holstein and 2 were Brown Swiss.

The effect on investment and net income of changing the pasture system was tested by budgeting for farms with 27, 38, 60, and 120 cows. For the 27-cow farm, a change from continuous to field-grazing would add \$400 to investments and almost \$350 to net income. A change from field-grazing to strip-grazing would increase investments by only \$300 and net income by \$237. A green-chopping system would increase investments over field-grazing by \$1,300 but would be no more profitable.

For a dairy farm with 180 acres of cropland and 38 cows, a change from field-grazing to strip-grazing would add only \$300 to investments and slightly more than \$300 to net income. Investment of \$1,900 in a direct-chopper and wagons for a green-chopping system would increase net income by \$200. Investment in a conventional chopper, blower, wagons and other equipment used for both green-chopping and silo filling would add \$4,300 to investments but nothing to net income. A system of storage-feeding would add \$3,900 to investments for a conventional chopper and other silo equipment but very little to net income. If the silo-filling was custom-hired for both summer and winter feeding, there would be very little change in investments and a possible gain of \$300 in net income.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Lang, R., and Landers, L. BEEF PRODUCTION AND GRAZING CAPACITY  
FROM A COMBINATION OF SEEDED PASTURES VERSUS NATIVE RANGE.  
Wyo. Agr. Expt. Sta. B. 370, 12 pp. 1960.

Grazing capacity and beef production from a combination of seeded pastures grazed at their optimum period of growth was compared with native range at the Gillette, Wyo., Substation in 1954.

The seeded pastures consisted of standard crested wheatgrass for spring grazing, intermediate wheatgrass for summer grazing, and Russian wildrye for fall grazing. Each of these species was seeded with alfalfa and yellow-blossom sweet-clover. The native range was a mixture of shortgrasses, midgrasses, and forbs with some big sagebrush present in the composition.

Yearling Hereford steers were used as experimental animals, and weight records were taken periodically, so that gains could be calculated by either specific dates or for specific pastures.

Animal gains per day were similar for both seeded and native pastures. Gains per acre and grazing capacity were from 2 to 3 times as great from the combination of seeded pastures as from native range. The differences between pasture types were greater in 1957 and 1958 than in the three previous years of test.



Clipped plots showed that in 1955, 1956, and 1957 a considerable amount of forage remained on all pastures after grazing. Utilization was not measured in 1958 but was judged to be nearly complete.

When costs were calculated on a local custom-rate basis and no credit allowance was made for A.S.C. payments, the cost of establishing the seeded pastures plus some profit was realized during the first 4 years of grazing. These seeded pastures are expected to be productive for an additional 6 years, with little or no additional costs. This combination of seeded pastures should show considerable economic advantage over an equal acreage of native range.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

Köger, M., Blue, W. G., Killinger, G. B., Greene, R. E. L., Harris, H. C., Myers, J. M., Warnick, A. C., and Gammon, N., Jr. BEEF PRODUCTION, SOIL AND FORAGE ANALYSES, AND ECONOMIC RETURNS FROM EIGHT PASTURE PROGRAMS IN NORTH CENTRAL FLORIDA. Fla. Agr. Expt. Sta. B. 631, 76 pp. 1961.

Five years' results from the first phase of a coordinated study of pasture programs for beef production in north central Florida are presented. Eight programs at the Beef Research Unit, Gainesville, were evaluated from the standpoint of beef production with a cow-calf operation, soils analyses, forage production, forage composition, and an economic analysis of each program.

The authors gave the following conclusions for the major results: (1) Where moisture conditions are favorable for clover growth, cow-calf operations on flatwoods pastures can be made to produce beef at a substantial profit with prices prevailing from 1952 to 1958. (2) Clover-grass pastures fertilized at the rate of 600 pounds of 0-12-12 annually produced substantially the same amount of forage and had a carrying capacity for cattle similar to pastures receiving twice this amount. (3) Clover-grass pastures produced beef at approximately 60 percent of the cost for all-grass pastures. The advantages for the clover-grass pastures included a higher weaning percent (83 vs. 64 percent), slightly heavier calves (427 vs. 416 pounds) and a lower cost per head for supporting cows (\$56 vs. \$79). And (4) the results of this trial indicate that all-grass pastures on areas comparable to the Beef Research Unit are not profitable for cow-calf operations. Costs per pound of beef produced on grass programs increased as rate of fertilization was increased.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Burson, P. M., Harvey, A. L., and Schmid, A. R. BEEF FROM GRASSLANDS. Minn. Agr. Expt. Sta., Sta. B. 452, 34 pp. 1961.

The production of beef from forage requires careful attention to every important factor which might influence the production. Neglect of any factor may result in poor returns. If the aim is to get cheap gains on pasture, the calves must be wintered so that they will gain no more than about 1 to 1-1/3 pounds per head per day. Beef animals that put on more weight than that during the winter will not make maximum gains on pasture.

The pastures must be productive. A soil test should be taken and lime fertilizer applied if needed to grow a good legume-grass mixture.

The fertilization of legume-grass mixtures for pasture is essential for profitable production. The application of the first increment of 300 pounds of 0-20-20 at seeding time to a legume-grass mixture was the most effective increment in increasing clipping yields for the two succeeding years. The addition of nitrogen to legume-grass mixtures increased the grass percentage which aided in preventing bloat. A rate of 60 pounds of nitrogen applied to a mixture in April was as effective as a split application (30 pounds in April and 30 pounds in June) in increasing yields. Some caution must be taken in applying nitrogen to legume-grass mixtures. Where a desirable legume-grass composition is present, the

addition of too much nitrogen annually will increase the grass composition to the point where legumes, which are high yielding, will be producing very little.

Manure applied to grass pasture at 8 tons per acre annually was more effective in increasing pasture clipping yields than 80 pounds of nitrogen applied annually.

Pasture mixture studies have shown that a mixture of 5 lb. alfalfa, 1 lb. alsike clover, 6 lb. bromegrass, and 2 lb. orchardgrass per acre has produced high yields and no bloat. Orchardgrass sometimes suffers from winter injury. Ladino clover was dropped from use in these pastures because it tended to aggravate the bloat problem.

Growing legumes in alternate single or double rows (6 inches apart) along with grass was not effective in controlling the legume-grass composition and caused a reduction in pasture yield as compared to a mixture with legume in every drill row.

Pasture renovation studies showed that surface tillage starting in early fall using deep-tillage type equipment, such as the Graham Hoeme, is most effective. Plowing is somewhat dangerous from the standpoint of erosion. The ordinary field cultivator did not penetrate well and tended to clog. Effective work can be done with the ordinary field cultivator but pasture sods must be thin and closely grazed.

U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Moss, R. B., and McRainey, N. D. THE MANAGEMENT SYSTEM FOR GRAZING AND FEEDING STEERS AT THE SOUTHWEST GEORGIA BRANCH EXPERIMENT STATION. Ga. Agr. Expt. Sta. C. N.S. 21, 23 pp. 1961.

When one decides to graze or feed steers, he should consider certain factors that are related to an enterprise of this kind regardless of the management system selected. Some of these factors are as follows: (1) A considerable amount of capital is required depending on prices, size of the operation, and the management system selected; (2) the enterprise appears to be "risky" from the standpoint of changing of prices, obtaining or purchasing feeder cattle of desired weight and quality, diseases, weather conditions, and other hazards of nature; (3) a vast amount of knowledge is required about buying, feeding, and selling cattle; (4) dependable labor with close supervision is required; and (5) investment in physical facilities, particularly fences, is practically non-recoverable if the enterprise is discontinued and not replaced by a comparable enterprise.

Data obtained for this study indicate that approximately 55 steers would be required to realize \$1,000 of net income using this management system. The total expenses for an operation of this scale would amount to \$9,222 annually.

The price spread between the purchasing and selling price per hundred-weight and the weight of the steers purchased in relation to the price spread are highly important factors in making a profit from feeding and grazing steers. With a wide positive spread between purchasing and selling prices, it would be more profitable to purchase heavier weight steers than if a narrow spread existed. When a negative spread between purchasing and selling price existed, the net returns per steer were also negative.

A steer grazing and feeding enterprise can be advantageous in some farm organizations. The farm management unit of the Southwest Georgia Branch Experiment Station used the steer feeding and grazing enterprise as a supplemental enterprise to use total resources on the farm for increasing net farm income.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Browning, C. B., Cowsert, W. C., Craft, W. D., and Miles, J. T. PERMANENT VS. TEMPORARY SUMMER PASTURES FOR MILK PRODUCTION. Miss. Agr. Expt. Sta. B. 624, 8 pp. 1961.

Milk production per cow was higher and persistency of production greater for cows grazing Sudangrass than grazing either Coastal Bermuda or Dallisgrass. Dallisgrass was higher in quality than Coastal Bermuda.

Coastal Bermuda pasture provided more cow-days and produced more nutrients per acre at a lower feed cost per 100 pounds of milk than did either of the other two grasses. These differences were greater during dry years, indicating a greater drought resistance for Coastal Bermuda.

In a situation where daily production per cow is more important than total yield per acre greater emphasis must be put on the higher quality temporary pasture crops.

Miss. State U., Agr. Expt. Sta., State College, Miss.

### Rangelands

Humphrey, R. R. ARIZONA RANGE GRASSES: THEIR DESCRIPTION, FORAGE VALUE, AND MANAGEMENT. Ariz. Agr. Expt. Sta. B. 298, 104pp. 1960.

The rancher should know as much about the plants that occur on the range as he does about management of his livestock. This pamphlet describes 71 range grasses important to the State of Arizona and gives their identifying characteristics, seasonal forage values, and the management practices that will maintain each grass in a productive condition.

Agr. Expt. Sta., U. Ariz., Tucson, Ariz.

Humphrey, R. R. FORAGE PRODUCTION ON ARIZONA RANGES: V. PIMA, PINAL AND SANTA CRUZ COUNTIES. Ariz. Agr. Expt. Sta. B. 302, 137 pp. 1960.

A "culture and care" bulletin on range production in Pima, Pinal, and Santa Cruz Counties in Arizona is presented. Five vegetation types in various condition classes are described and illustrated. Some of the common plants growing in the area are illustrated and the grazing value of each given.

Ariz. Expt. Sta., U. Ariz., Tucson, Ariz.

Klipple, G. E., and Bement, R. E. LIGHT GRAZING--IS IT ECONOMICALLY FEASIBLE AS A RANGE-IMPROVEMENT PRACTICE? J. Range Mangt. 14: 57-62. 1961.

Light grazing has been used only infrequently by rangeland managers as a range-improvement practice. Their reasons for not doing so arise from doubt on their part as to its economic feasibility and its effectiveness. Results from a number of controlled grazing-intensity studies reported over the past 20 years are analyzed in relation to the validity of these doubts.

Light grazing for a few years does increase the herbage-yielding ability of deteriorated native ranges. The cost of applying light grazing is low in comparison with costs of other methods often used for range improvement. The logical time to use light grazing for range improvement is before the range has become depleted. Light grazing cannot do the job alone when competing undesirable vegetation dominates the site. Results of grazing-intensity studies demonstrate that



light grazing is economically feasible when results are expressed in dollars received for the forage per acre of rangeland.

CRD, ARS, USDA, Fort Collins, Colo.

Paulsen, H. A., Jr., and Ares, F. N. TRENDS IN CARRING CAPACITY AND VEGETATION ON AN ARID SOUTHWESTERN RANGE. J. Range Mangt. 14: 78-83. 1961.

During years of low precipitation on black grama and tobosa grasslands and associated shrub ranges of the Southwest, herbaceous cover is reduced and in years of more favorable rainfall it recovers. During a series of dry years on the Jornada Experimental Range in south-central New Mexico, basal area of black grama was reduced to approximately the same point irrespective of grazing intensity. Recovery of black grama was greatest where grazing usually removed less than 40 percent of the herbage. Tobosa maintained its greatest basal area under somewhat heavier grazing, which removed 40 to 55 percent of the annual herbage growth.

Sustained grazing capacity does not exist on these semi-desert ranges. There are periods of high forage production and periods of low forage production. Stocking may be high in some periods and in others there is virtually no capacity. During periods of deficient rainfall, forage production declined irrespective of the grazing use and the best management. Twice in 40 years on the Jornada Experimental Range it was necessary to remove nearly all the cattle during extreme drought periods, despite application of the best known techniques of range management.

Where shrubs such as mesquite are in the initial stages of invasion of the grassland areas, an active and continuing program of brush control is mandatory. Otherwise, an ever-increasing decline in grazing capacity must be anticipated. Once the mesquite sandhills stage is reached, it is presently not economical to attempt control.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Soil Conserv. 26(6): 128-144. 1961.

This issue of the Soil Conservation magazine is devoted predominantly to range conservation and contains the following articles:

Williams, D. A. RANGE CONSERVATION. SCS, USDA, Washington, D. C.

Anonymous. THE RANGE CONSERVATION POSTAGE STAMP.

Leithead, H. L. TAKE HALF AND LEAVE HALF. SCS, USDA, Denver, Colo.

Saulisberry, C. N. SOD BUSTING ON MOUNTAIN MEADOWS. SCS, USDA, Cedarville, Calif.

Swanson, R. E. PIPE REPLACES DITCH. SCS, USDA, Eagle, Ohio.

Yarlett, L. L. RANGE MANAGEMENT IN FLORIDA. SCS, USDA, Sebring, Fla.

Pederson, R. J. YOUTH RANGE CAMP IN TEXAS. SCS, USDA, San Angelo, Tex.

Willhite, F. M., and Rouse, H. K. MOUNTAIN MEADOW IMPROVEMENT. ARS, USDA, Fort Collins, Colo.

Price, J. B. THORN CREEK CATTLEMEN WORK TOGETHER. SCS, USDA, Thin Falls, Idaho.

Nurmi, E. O. LATAR ORCHARDGRASS. SCS, USDA, Pullman, Wash.

Crowley, C. D. THEY FARM THE BOTTOMLANDS AGAIN ON JOHNSON CREEK WATERSHED. SCS, USDA, Nashville, Tenn.

Earle, J. B. RECLAIMING GRAVEL MINES. SCS, USDA, Columbus, Ohio.

Anderson, K. L. BURNING BLUESTEM RANGES. Crops and Soils 13(5): 13-14. 1961.

Tests at Kansas State University have revealed a number of interesting facts about the effects of burning bluestem ranges.

Burning has a profound effect on amount of available soil moisture. Burning removes protective mulch, allows surface soil to puddle during rains, increases runoff, and the rate of moisture intake is reduced. Soils of bluestem ranges burned during the spring are drier than if left unburned, and the earlier the burning, the drier the soil. This is reflected in forage yields that are closely related to amount of soil moisture available for plant growth. In dry seasons, the differences in forage yield between burned and unburned areas are extreme.

Fire has been said to kill weeds. This has not been true on bluestem ranges unless burning has been delayed until the last week in April. Weeds have actually increased in trial plots burned during winter or early spring.

Research has shown that burning does increase gains per head--at least for a number of seasons--but the reduced yields of forage make it necessary for the rancher or farmer to allow increased acreages if overgrazing is to be avoided.

Over a 10-year period, late spring burning (May 1) has resulted in average annual gains of 266 pounds per head, compared with 242 pounds of gain under early spring burning (March 20) and only 235 pounds of average gain per head on unburned range.

Range burned in the early spring has deteriorated severely in terms of bluestem grass cover and in vigor of growth, while range burned during the late spring has been maintained fairly well.

Kans. State U., Manhattan, Kans.

Dix, R. L. THE EFFECTS OF BURNING ON THE MULCH STRUCTURE AND SPECIES COMPOSITION OF GRASSLANDS IN WESTERN NORTH DAKOTA. Ecology 41: 49-56. 1960.

The results of a preliminary quantitative study of the species composition, herbage production, and mulch structure on natural grasslands following fire of known age in western North Dakota are reported. Partner pairs of stands, one burned and the other unburned, were sampled. In three pairs of such stands, the species composition was determined by employing 40 1/4 m<sup>2</sup> quadrats in each stand and the surficial organic matter was clipped and segregated according to the system described by Dyksterhuis and Schmutz (1947).

The results of the study showed the frequency values of most species to be relatively similar on the burned-unburned partner stands. Notable exceptions occurred in one stand of Artemisia glauca, which had a higher frequency in the burned than in the unburned stand. Lactuca pulchella, Calamovilfa longifolia,

and Selaginella densa had higher frequencies in the unburned partner. No suggestion was offered to explain these behaviors, except in the case of Artemisia glauca where the general weedy habit of the species appeared to account for its increase following fire. The greatest differences in species composition were found on the oldest burn, suggesting a lag in the adjustment of perennial species to the fire modified environment.

In order to evaluate differences in overall species composition of the stands, an index of stand similarity was employed. This analysis showed the similarities between partner stands to be consistently greater than similarities between any stands other than partners.

The results of the clipping studies showed a remarkably rapid recovery of the mulch structure on a Stipa comata stand which had been burned in 1954. The mulch structure had completely recovered by the end of the fourth growing season following the burn. The mulch structure on a burned Agropyron smithii stand also appeared to be making a rapid recovery, although at a somewhat slower rate than in the Stipa stand. This difference appeared to be due to heavier and more recent grazing on the Agropyron stand and also to an inherent slower recovery rate of the Agropyron community.

Detailed comparisons were made between the results of the present study and the results reported from a previous study on two isolated mesas in western North Dakota. These comparisons indicated that: (1) The annual production of herbage on the Stipa comata community was approximately 1,900 lbs. of air-dried material per acre; (2) the average total mulch on the Stipa community was approximately 5,500 lbs./acre; (3) the accumulation of fresh and humic mulches did not retard the production of herbage in either the Stipa or Agropyron communities; (4) light grazing tended to increase the amount of humic mulch and decrease the amount of fresh mulch on a stand; and (5) moderate grazing tended to decrease both the fresh and humic mulch weights on a stand.

Marquette U., Milwaukee, Wisc.

Weaver, J. W. COMPARISON OF VEGETATION OF KANSAS-NEBRASKA  
DRIFT-LOESS HILLS AND LOESS PLAINS. Ecology 41: 73-88. 1960.

The Drift-Loess Hills of northeastern Kansas and southeastern Nebraska are like the Loess Plains in topography, except that the hills are more pronounced in the east and more level land alternates with lower hills in the Loess Plains westward. Both have highly productive soils. Eastward glacial boulders and limestone outcrops are common. On the Loess Plains the bedrock is nearly completely covered with loess. Soils in the Chernozem Zone westward are somewhat less productive than those in the Brunizem Zone eastward, not because of lack of innate fertility, but because of reduced precipitation. Precipitation ranges from 29 to 34 inches in the east, to 27 to 28 inches in the west. Since altitude and latitude are similar, the length of the growing season is nearly the same. Humidity is lower and drying winds are higher and more frequent in the west. Evaporation is also greatly increased westward and periods of drought are more frequent and of longer duration.

Both areas of True Prairie are composed of the Andropogon scoparius type on uplands and the A. gerardi type on lower slopes and low, level lands. On mid slopes the two bluestems may intermix about equally. In the west, the little bluestem type occupies a greater portion of the prairie than eastward, the grass more often occurs as bunches and frequently intermixes with big bluestem on lower slopes. Sporobolus heterolepis is common and sometimes locally abundant eastward; it did not occur at the western stations. Stipa spartea was common but rarely abundant eastward; it was usually absent in the west. Panicum virgatum and Sorghastrum nutans were of considerable abundance (5-20 percent) eastward and ranged widely; westward they were much less abundant and more restricted to ravines and low ground.



Midsummer foliage level of little bluestem was often 16 to 24 inches in the east but 8-18 inches westward; similar average heights of big bluestem were 18-26 and 26-36 inches. The general foliage cover was not only higher but also considerably denser eastward. Westward, Bouteloua curtipendula and Koeleria cristata became far more abundant, and the low-growing Panicum scribnerianum, P. wilcoxianum, and Carex pennsylvanica greatly increased in amount. Great Plains grasses, not observed in mowed prairies eastward but common westward, were Bouteloua gracilis and Buchloe dactyloides. The following species of Mixed Prairie grasses also occurred in some western mowed prairies: Agropyron smithii, Aristida purpurea, Festuca octoflora, Schedonnardus paniculatus, and Muhlenbergia cuspidata.

In the bluestem prairies of northeastern Kansas and southeastern Nebraska 65 to 100 species of forbs were usually observed in selected prairies 40 to 60 acres in extent. Westward the lists were shorter, 35 to 60 species. Forbs were greatly reduced in stature westward, there were fewer and less well developed societies, and numerous species common to Mixed Prairie were present.

U. Nebr., Lincoln, Nebr.

Valentine, K. A., and Norris, J. J. MESQUITE CONTROL WITH 2, 4, 5-T BY GROUND SPRAY APPLICATION. N. Mex. Agr. Expt. Sta. B 451, 24 pp. 1960.

Results of experimental work on mesquite control with 2, 4, 5-T formulations applied to plants individually with ground equipment are reported.

Of formulations tested, an amine and propionic acid ester produced significantly poorer kills than the propylene glycol butyl ether esters. No formulation exceeded the PGBE (propylene glycol butyl ether) esters in effectiveness. Concentrations were tested at 0.10, 0.15, 0.20, and 0.25 percent acid basis in aqueous solutions without disclosing significant differences, but the 0.15 percent concentration slightly exceeded the others in effectiveness.

None of the additives used produced kills significantly higher than the material without additive, but there were some indications that low percentages of non-phytotoxic oils might increase kills.

Seasonal tests showed a distinct sharply rising peak in effectiveness in early June during 5 of the 6 years in which these tests were made, after which effectiveness exhibited a distinct but less sharp decline. The onset of the season of highest effectiveness was indicated phenologically by full development of the leaf cover, and kills continued to hold up acceptably well until the fruit was fully elongated but still flat and green.

Yearly influences were found to be among the most important disclosed in the work, the influence of years being associated with rainfall during the fall-winter-spring before spraying in late spring and summer. Fall-spring periods with low rainfall supported kills ranging between 8 and 30 percent, while the same periods with high rainfall supported kills of 68 to 84 percent. An 1-inch increase in fall-spring precipitation (adjusted for time elapsed before spraying in May or June) was associated with an increase in kill of 38.8 percent.

Cost of mesquite control with the ground spray method on lightly-to-moderately-infested rangeland, including labor, equipment, and material, ranged from \$0.54 to \$1.65 per acre and averaged \$1.15 per acre. Costs were roughly proportionate to mesquite infestation, which ranged from 10 to 154 plants per acre and averaged 82 plants per acre. Kills (complete kill of tops and roots) ranged from 38 percent in the driest year (fall-spring precipitation) to 90 percent in the wettest year and averaged 54 percent. Top kills approaching 100 percent were obtained in each year of treatment; these are of considerable value in reducing range damage by mesquite. Plants surviving the treatment did not regrow to seed-producing size for up to 8 years.

In planning mesquite control work, priority should be given to defense against invasion wherever remnant perennial grasses are in sufficient amounts to respond to removal of mesquite. Stands of mature plants which serve as seed sources for infestation of uninvaded range also should be high on the priority list.

Important points to keep in mind are: (1) Choice of chemical (low volatile 2, 4, 5-T esters); (2) choice of concentration (0.15 percent is sufficient for high volume spray); (3) proper time of spraying (leaves fully developed to fruits fully elongated but not hardening); (4) choice of year and area with best prospects for satisfactory kill; and (5) complete coverage of plants with spray material.

N. Mex. State U., Agr. Expt. Sta. University Park, N. Mex.

Cable, D. R., and Tschirley, F. H. RESPONSES OF NATIVE AND INTRODUCED GRASSES FOLLOWING AERIAL SPRAYING OF VELVET MESQUITE IN SOUTHERN ARIZONA. J. Range Mangt. 14: 155-159. 1961.

Herbage production of native perennial grasses and Lehmann lovegrass was compared on sprayed and unsprayed portions of a velvet mesquite-infested pasture.

In 1959, five growing seasons after the final spray treatment, mesquite mortality was 58 percent on the area sprayed with  $3/4$  pound of 2, 4, 5-T in each of the 2 successive years. On the area sprayed with  $3/4$  pound followed by  $1/2$  pound of 2, 4, 5-T, mortality was 36 percent; and on the area sprayed once, 2 percent. Defoliation in 1959 was 95, 86, and 17 percent, respectively, on the three treatment areas.

Herbage production of native perennial grasses averaged almost twice as much on the sprayed as on the unsprayed area for the six growing seasons after the first spraying. Herbage production of lovegrass averaged more than three times as much on the sprayed as on the unsprayed area during the same time. No difference in perennial grass herbage production between the two areas sprayed twice was apparent.

Increased production of perennial grass on the areas sprayed twice more than paid the cost of spraying and seeding in the first three growing seasons after the first spraying. The slow rate of mesquite recovery indicates that the effects of the treatment will last several more years.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

McCaleb, J. E., Hodges, E. M., and Dantzman, C. L. EFFECT OF HERBICIDAL CONTROL OF SAW PALMETTO ON ASSOCIATED NATIVE FORAGE PLANTS IN PENINSULAR FLORIDA. J. Range Mangt. 14: 126-130. 1961.

The effect of five herbicides in three water-oil carrier solutions, applied in September and October 1957, on species composition and ground density of native forage plants growing in association with saw palmetto without serious damage to forage plants, was determined in May 1959. The largest percent of buds killed was in plots treated with 2, 4, 5-T in 100 percent water. Larger amounts of oil in the carrier decreased palmetto kill with 2, 4, 5-T, 2, 4, 5-TP, and erbon but increased control with 2, 4-D and dalapon. The same relationship occurred in total intercept of grass and grasslike plants. Preferential grazing by cattle on plots without oil in the carrier may account for part of the rise in density of decreaser grasses. Woody shrubs were fewer in all herbicidal treatments compared with the check. Shrubs increased in percent species composition when greater amounts of oil were used in the carrier.

Range Cattle Expt. Sta., Ona, Fla.

Technical recommendations are available to guide ranchers in seeding ranges to improved forage production. Before investing in seeding their own or publicly owned ranges, ranchers want to know, "Will it pay?"

Seeding profitably can be estimated by budgeting and use of valid economic principles.

Costs of seeding may include the following 13 items: (1) Removing unwanted vegetation; (2) preparing a seedbed; (3) planting; (4) seed; (5) nonuse until the new grass is ready; (6) new fencing; (7) pest control; (8) overhead; (9) new water developments; (10) hauling water; (11) interest on investment; (12) operation and maintenance of fence and water facilities; and (13) renovation of the seeding.

The average initial investment in 20 seedings studied was \$8.92 per acre. This does not include costs of water development, periodic renovation of the stand, or maintenance of fences and water facilities. Interest on this investment, at 6 percent, cost \$1.70 per acre during 3 years of nonuse and \$7.89 per acre during a 20-year amortization period.

Returns from use of seedings may be classified as nonmarket and market returns. Market returns are realized by the rancher whose stock graze a seeding. They result from increased production of salable livestock due to increased quantity and improved quality of range forage, which increases carrying capacities and rate of gain while lowering death losses and raising lamb or calf crops. Returns are influenced by the rancher's management as well as by the productivity of the land and the success of the seeding.

Based on changes in carrying capacity, increased rate of animal gain, and increased calf and lamb crops, spring use of seeded crested wheatgrass stands resulted in the following calculated increases in annual gross returns: (1) \$3.60 per acre for use by yearling cattle; (2) \$1.99 per acre for use by cows and calves; and (3) \$4.93 per acre for use by ewes and lambs.

Analysis of costs and returns from crested wheatgrass seedings on publicly owned ranges in western Utah indicates that those that produce a satisfactory stand of grass are profitable even when seeding costs are high and drought reduces grass yields below normal.

Agr. Expt. Sta., Utah State U., Logan, Utah.

Merrill, L. B., and Miller, J. E. ECONOMIC ANALYSIS OF YEAR-LONG GRAZING RATE STUDIES ON SUBSTATION NO. 14, NEAR SONORA. Tex. Agr. Expt. Sta. MP-484, 8 pp. 1961.

The effects of combination grazing contrasted to grazing of single classes of livestock at different rates of stocking is being studied at Substation no. 14, near Sonora, Tex. This report covers the results of research for the first 7 years, 1949-56.

Pastures were more productive when stocked with a combination than when stocked with only one kind of livestock. Different stocking rates showed significant differences in their effects on range condition. Relating these items, an adjusted gross return per acre, taking into consideration changes in range condition, for each pasture was computed. After this adjustment, significant differences remained between kinds and combinations of livestock grazed. Pastures stocked with cattle, sheep and goats remained the most productive, followed by cattle and goats, sheep, and cattle, respectively.

There was little difference in production of animal products between pastures stocked at the heavy and moderate rates, with the exception of the pastures stocked with cattle alone. Pastures stocked with cattle alone had higher adjusted gross returns under moderate than under heavy stocking. All of the



pastures stocked at the lightest rate yielded adjusted gross returns per acre significantly lower than the moderate or heaviest rates.

Costs such as labor, interest on investment, and veterinary costs influence management decisions. The investment per animal unit of cattle was considerably greater than the investment per animal unit of goats. Consideration of these factors would have made the moderately stocked pastures appear even more favorable in this comparison.

In order to maximize production per acre on rangelands, ranchmen should consider stocking the types of livestock best adapted to the type of vegetation present. For example, pure grasslands are best adapted to cattle production; cattle and sheep do well where weeds are present; and cattle, sheep and goats are adapted where grass, weeds, and palatable browse are present. On rangelands similar to those on the Sonora Station, ranchmen should consider stocking a combination of cattle, sheep, and goats, rather than cattle or sheep alone.

There was little difference in production value per acre under moderate and heavy stocking. Ranchmen would be wiser to stock moderately during periods of similar climatic conditions, since range condition improved under moderate stocking and deteriorated under heaviest stocking.

Flexibility in stocking to meet changing rainfall and vegetative conditions is necessary. This may be achieved by careful culling and early sale of culled breeding animals, holding over calves, lambs, or kids in the fall or by purchasing other dry stock for sale after quick gains, or when grazing conditions begin to deteriorate. A safe method of achieving this flexibility would be to utilize 70 percent of the animal units for the base herd and 30 percent for dry stock.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

### Plant Materials

Harvey, T. L., Hackerott, H. L., Sorensen, E. L., Painter, R. H., Ortman, E. E., and Peters, D. C. THE DEVELOPMENT AND PERFORMANCE OF CODY ALFALFA, A SPOTTED ALFALFA APHID RESISTANT VARIETY. Kans. Agr. Expt. Sta. Tech. B. 114, 27 pp. 1960.

The urgent need of a spotted alfalfa aphid-resistant variety adapted to Kansas prompted the release of Cody alfalfa, a resistant variety derived from Buffalo. Cody was developed in a single cycle of selection by screening seedlings of Buffalo for survival after spotted alfalfa aphid infestation. Twenty-two clones were selected from among the surviving plants primarily on the basis of caged-leaf antibiosis tests and seedling survival of progenies. Although resistance was increased with a second cycle of selection, Cody was about equal in resistance to Lahontan, a variety that has shown satisfactory resistance to spotted alfalfa aphids in other areas. Cody was established during cool fall weather under heavy spotted alfalfa aphid infestation in field plots in which seedlings of Buffalo alfalfa resulted in failure. Forage yield data indicated that Cody and Buffalo were about equal when spotted aphids were not a factor. Cody should satisfy the present need for protection against spotted alfalfa aphids in Kansas and may prove valuable in areas where Buffalo is now successfully grown.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Dugan, R. F. MULTIFLORA ROSE IN WEST VIRGINIA. W. Va. U. Agr. Expt. Sta. B. 447, 34 pp. 1960.

Multiflora rose has been widely used in conservation plantings throughout the United States during the past 25 years. Its chief values are as a living fence and for wildlife cover and food.

In West Virginia, approximately 14 million multiflora rose plants have been distributed to farmers and other landowners.

A survey of existing plantings was made during the summers of 1954, and 1955. This survey included 282 plantings, located in 44 counties, under 170 different ownerships, covering a range of 350 to 3,000 feet elevation, and a wide variety of site conditions and management practices. Data collected indicate the following conclusions and recommendations:

1. Multiflora rose grows well and develops into a highly effective living fence practically anywhere in West Virginia. It is also one of the finest wildlife cover plants yet found, and is a good source of emergency winter food.
2. It is not a miracle plant, but requires a reasonable amount of management to produce the desired results. Its main requirements are moisture, fertility, and protection from competition and grazing. It should not be planted under the branches of trees.
3. The best insurance of success is to select a good site. Three cultural practices are also recommended: plowing and disking in advance of planting, use of a high-nitrogen fertilizer, and cultivation for the first 2 or 3 years. The rose should be protected from livestock until it is at least 3 years old.
4. Any gaps caused by the death of one or more plants must be filled in immediately either by new seedlings or by tip layering from adjacent plants.
5. Multiflora rose will spread by layering when the tips are covered with soil or plant debris. Mowing once or twice a year will effectively control this. It will also spread by seed into idle or unmanaged land. It does not get started in cultivated fields or in pastures that are closely grazed and mowed. In brushy pasture or idle land, or along fence rows, control of seedlings is easily accomplished by either machine or hand mowing, or by the use of brush-killer spray (2, 4, 5-T).
6. If sheep and hogs are to be confined by the rose fence, a spacing of 6 inches in a single row is advisable. For horses and cattle only, 1-foot spacing is adequate.
7. The rate of growth of multiflora rose does not appear to be affected by any of the diseases or insects found in this State.
8. Multiflora rose has some disadvantages. It needs management during the first 2 or 3 years especially, and in some situations, spreading must be controlled. But 98 percent of the farmers interviewed in this survey felt that these faults were greatly outweighed by its advantages--its economy and effectiveness as a living fence, plus its wildlife and esthetic values.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Linduska, J. MULTIFLORA ROSE--MULTIPURPOSE HEDGE. Outdoor America 26(4): 8-9. 1961.

Multiflora rose is at its best in the humid, eastern half of the country from the Mississippi to the coast. It prefers moderately heavy soils but can be brought along on lighter ground if mulched and fertilized liberally. It won't grow in dense shade or on poorly drained land.

To fence pastures, a double row is best. Set the young plants every foot or 18 inches. Locate a second row 2 to 3 feet from the first and interplant the gaps by staggering the plants.

All told, multiflora is a full-time all-purpose friend of the farmer. No other plant can boast the ability of containing cattle while excluding trespassers the year around, of functioning as a snow fence in winter and a nursery for song-birds in the spring, and of being a predator-proof escape hatch for rabbits and

game birds. It adds an element of beauty to the farm scene that's in sharp contrast with bleak barbed wire.

Public Relat. and Wildlife Mangt., Remington Arms Co., Inc.

Klein, L. M., Harmond, J. E., and Hurst, W. M. SEED LOSSES IN HARVESTING SOME GRASS AND LEGUME CROPS IN THE WILLAMETTE VALLEY, OREGON, 1953-1954. U. S. Dept. Agr., Agr. Res. Serv. ARS 42-48, 20 pp. 1961.

Losses in harvesting and threshing crimson clover, Alta fescue, hairy vetch, bentgrass, and subterranean clover during the 1953-1954 seasons in the Willamette Valley, Oreg., ranged from 19 percent for bentgrass to 77.4 percent for subterranean clover. With crops such as wheat, oats, and soybeans and with the same methods and machines, seed losses associated with harvesting usually range from about 5 to 10 percent.

Studies of individual operators show that farmers can do much in reducing seed losses in harvesting some grass and legume crops. These include timely harvest, machine adjustments, and selection of method (combine or windrow-combine). Recommended methods to reduce seed losses in harvesting the grass and legume crops are discussed and illustrated.

ARS, USDA, Inform. Div., Washington 25, D. C.

Canode, C. L., and Patterson, J. K. GRASS SEED PRODUCTION FROM SEEDED RANGE LANDS. J. Range Mangt. 14: 88-92. 1961.

Three experiments conducted at Hooper, Wash., under 12 to 13 inches average precipitation at an elevation of about 1,500 feet demonstrate the feasibility and desirability of producing seed from range seedings before using them as grazing units.

Crested wheatgrass produced an economical crop of seed (219 pounds per acre) in the second growing season without nitrogen fertilization. With an application of 20 pounds of nitrogen per acre, yields averaging 179 pounds per acre were obtained for the 4 years harvested. Forty pounds of nitrogen per acre produced an average of 326 pounds of clean seed per acre per year over the 4-year period.

Of 15 varieties and strains of various species tested, only 5 produced good stands under limited moisture conditions. One of the 5 entries, Russian wildrye, produced good stands but made essentially no seed. The other 4 entries, all drought-tolerant wheatgrasses, produced good yields of seed the second growing season. Siberian wheatgrass and crested wheatgrass produced 428 and 345 pounds of clean seed per acre, respectively. Sodar streambank wheatgrass produced 117 pounds of seed after a slight loss by shattering. Whitmar bluebunch wheatgrass produced 96 pounds after losing almost half of the seed by shattering. These four wheatgrasses did not produce enough seed for harvest in the third year due to competition from cheatgrass. In the fourth year, crested and Siberian wheatgrasses produced an average of 180 pounds of clean seed per acre.

Another experiment indicated that intermediate wheatgrass would produce good seed yields under limited rainfall if grown in thin, uniform stands on deeper soils.

CRD, ARS, USDA, Pullman, Wash.



Walstrom, R. J. INSECTICIDES INCREASE ALFALFA SEED PRODUCTION  
IN SOUTH DAKOTA. S. Dak. Agr. Expt. Sta. B. 499, 13 pp. 1961.

Under South Dakota conditions, as indicated by this 5-year test at Brookings, the use of insecticides will provide profitable increases in alfalfa seed yields.

As shown in the table below, it is important to determine the cost per acre of the insecticides used. The increased cost of applying two treatments as compared to single applications should be considered. The purchase price of insecticides may change from year to year and from area to area within the State. It is therefore important to analyze costs each year before deciding on the insecticide treatment to use.

Average Alfalfa Seed Yields for Different Insecticide Treatments at Brookings, South Dakota, from 1956 to 1960

Insecticide	No. appli- cations	Lbs. actual insecti- cide per for each application	Cost per A. of in- secticides used (dollars)*	Av. seed yield in lbs. per A.†	Av. value over check per A. (dollars)‡	Av. increase or decrease in profit per A. (dollars)§
DDT plus Toxaphene	2	1.00 1.50	4.02	56.13	5.01	0.99
DDT plus Toxaphene	2	2.00 2.00	6.77	61.15	6.06	-0.71
DDT plus Toxaphene	1	1.00 1.50	2.01	45.79	2.84	0.83
DDT plus Toxaphene	1	2.00 2.00	3.39	41.35	1.90	-1.49
DDT plus Aldrin	1	1.00 0.25	1.55	57.84	5.37	3.82
DDT plus Heptachlor	1	1.00 0.25	1.62	54.09	4.58	2.96
DDT plus Dieldrin	1	1.00 0.25	2.05	64.91	6.85	4.80
Lindane	1	0.25	2.49	59.74	6.18	3.69
DDT plus Chlordane	1	1.00 1.00	2.55	59.63	5.74	3.19
Aldrin	1	0.25	0.50	49.61	3.64	3.14
Heptachlor	1	0.25	0.57	44.11	2.48	1.91
Dieldrin	1	0.25	1.00	51.97	4.13	3.13
DDT plus Lindane	1	1.00 0.25	3.54	58.87	5.58	2.04
Chlordane	1	1.00	1.50	44.80	2.63	1.13
Malathion	1	1.00	2.50	47.26	3.14	0.64
Malathion plus Heptachlor	1	1.00 0.25	3.07	45.00	2.67	-0.40

Average Alfalfa Seed Yields for Different Insecticide Treatments at Brookings,  
South Dakota, from 1956 to 1960--Continued

Insecticide	No. appli- cations	Lbs. actual insecti- cide per for each application	Cost per A. of in- secticides used (dollars)*	Av. seed yield in lbs. per A.†	Av. value over check per A. (dollars)‡	Av. increase or decrease in profit per A. (dollars)§
Malathion plus Heptachlor	2	1.00 0.25	6.14	66.31	7.14	1.00
Methoxychlor plus Heptachlor	1	2.00 0.25	5.57	57.79	5.36	-0.21
Methoxychlor plus Heptachlor	2	2.00 0.25	11.14	62.51	6.35	-4.79
Check	--	--	--	32.29	--	--

\*Insecticide costs are based on 1960 retail prices.

†Clean seed yields are averaged for 1956-1960 tests.

‡Seed prices figured at 1960 average price received by farmers of \$21 per 100 pounds.

§Cost of application not included.

S. Dak. State Col., Agr. Expt. Sta., Brookings, S. Dak.

Allen, P. H., and Trousdell, K. B. LOBLOLLY PINE SEED PRODUCTION IN THE VIRGINIA-NORTH CAROLINA COASTAL PLAIN. J. Forestry 59: 187-190. 1961.

Thirteen-year seed-trapping records were used to evaluate seed production under different types of management.

Seed crop size fluctuated considerably from year to year in both uncut and partly cut stands. Almost invariably, stands within 30 miles of each other followed the same annual trend of seed production.

Stimulation by preharvest release of the seed source improved production, particularly in the poor seed years. Stimulated, selectively cut stands of mature trees produced more seed than uncut stands of a similar age. Stimulated strips and eight seed trees per acre produced quantities similar to uncut stands, and provided an ample seed source. Four mature seed trees per acre, stimulated by preharvest release, produced about as much as an uncut stand of the same age, but in some years this supply was inadequate. In poor years unstimulated seed sources generally did not provide sufficient seed for regeneration on unprepared sites.

Not only does release improve seed production, but it also produces a highly significant increase in the percentage of sound seed.

Stand age and density are important factors affecting seed production. Young forest-grown trees are generally unsatisfactory seed producers, unless stimulated by thinning or other preharvest release.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

The seeding characteristics of Virginia pine were studied on the Beltsville Experimental Forest, Laurel, Md., and on two stands near Springfield, W. Va. Seed dissemination from the north, east, south, and west edges of an uncut block of 35-year-old pine was measured from 1952 through 1954. Beginning in 1950, annual seedfall from many stands, including four seed-tree cuttings and two strip-cuttings, were sampled. Observations were made on the annual variations in seed production among stands and trees. The time during which Virginia pine seed falls from the cone was examined.

The results of these studies are: (1) Most Virginia pine seed is distributed by the prevailing winds; most falls within 100 feet of the stand in which it is produced. (2) A shortage of good seed-producing trees can be offset only in part by leaving more seed trees per unit of area. (3) Release of Virginia pine trees may stimulate seed production. (4) Variations in seed production among individual Virginia pine trees and stands are often great. The best guide to future seed production by individual trees is their past production. And (5) Virginia pine seed begins to fall in late October and continues until the following May. Most of the sound seed falls during October, November, and December.

Laurel Res. Center, Northeastern Forest Expt. Sta., FS, USDA, Laurel, Md.

### Woodlands

McGee, C. E. SOIL SITE INDEX FOR GEORGIA SLASH PINE. Southeastern Forest Expt. Sta., Sta. Paper 119, 9 pp. 1961.

The relationship between soil properties and site index for slash pine plantations in the middle coastal plain of Georgia was studied on 214 sample plots established throughout the area.

The soil properties found to be highly correlated with height growth were the thickness of the  $A_1$  horizon and the depth to a fine-textured horizon. Site quality increased as the thickness of the  $A_1$  horizon increased. Optimum growth was found on sites having a depth to a fine-textured horizon of 28 to 30 inches. On sites where this horizon was shallower or deeper, an adverse effect on height growth was indicated.

For field use of the data, a table and an alignment chart were prepared to supply a direct height estimate based on the two soil variables. Average site values for the various soil series samples were calculated and presented in tabular form.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Mader, D. L., and Owen, D. F. RELATIONSHIPS BETWEEN SOIL PROPERTIES AND RED PINE GROWTH IN MASSACHUSETTS. Soil Sci. Soc. Amer. Proc. 25: 62-65. 1961.

Results from a site study on 47 plots of plantation-grown red pine in Massachusetts indicate that growth is related to organic matter and nitrogen contents of the soil profiles and soil drainage class. Multiple regression of 5-year cubic foot volume growth per acre on total organic matter per acre of the solum and percent organic matter in the A horizon showed highly significant (1-percent level) partial and multiple regression coefficients. The regression accounted for 37 percent of the growth variability. The multiple regression coefficient for data on growth, log values for total nitrogen content per acre of the solum, and percent nitrogen in the A horizon from these plots also was highly significant, accounting for 35 percent of the variability in growth.



Regression using height growth of dominants from 20 to 30 years of age, height of dominants at age 25, or volume per acre at age 25 as a measure of growth gave poorer correlations with organic matter and soil nitrogen than 5-year cubic foot volume growth per acre. A multiple regression equation relating eight soil factors to growth was highly significant partial regression coefficients for total nitrogen and drainage class.

Organic matter, nitrogen, and drainage class appear to have some value in assessing site productivity although residual variability from other growth factors, or from error in sampling and analysis, is still appreciable resulting in prediction errors on the order of 10 percent of the average volume growth rate. Cubic foot volume growth gave better correlations with site factors than either total or periodic height growth.

Mass. Agr. Expt. Sta., U. Mass., Amherst, Mass.

Walker, L. C., Green, R. L., and Daniels, J. M. FLOODING AND DRAINAGE EFFECTS ON SLASH PINE AND LOBLOLLY PINE SEEDLINGS. Forest Sci. 7: 1-15. 1961.

Slash and loblolly pine seedlings planted in a plastic clay loam soil were continuously flooded to  $\pm 0$ , 4, and 8-inch depths; continuously drained to 4 and 8 inches below ground level; and flooded to a depth of three inches at 3-week intervals with subsequent drainage at  $1/8$ -,  $1/4$ -, and  $1/2$ -inch per day coefficients.

A supplemental study tested survival ability of slash and loblolly pine seedlings planted on waterlogged soil immediately after drainage, but subjected to subsequent 2-, 4-, and 8-week periods of inundation to 8 inches.

Results and suggested practical conclusions are:

1. Mortality was inversely related to height of seedlings. Terminal buds must be above water to survive more than a few weeks of inundation.
2. Slash pine seedlings in the plots began to die 68 days after initiation of flooding to 8-inch depths, and loblolly pine within 133 days. Flooding to 8-inch depths resulted in severe mortality, while flooding to 4-inch depths caused significant losses the first year. Slash pine inundated for periods longer than 2 months and loblolly pine for 4 months will probably require replanting.
3. One-year-old seedlings of slash and loblolly pine averaging 7.2 inches tall endured a maximum of 2 weeks under 8 inches of water without excessive mortality in the supplemental study.
4. First year height growth of loblolly pine on plots continuously drained to 4 and 8 inches below ground level considerably exceeded growth where water constants were maintained at ground level and at 4 and 8 inches above that point. Best growth of slash pine was on plots with drainage to a depth of 8 inches. By the end of the second year, greatest growth for both species was on the plots drained to 8 inches below ground level.
5. Among drainage coefficient plots, no real differences occurred between rates of water removal of  $1/8$ ,  $1/4$ , and  $1/2$  inch per day. One-eighth inch coefficients appear satisfactory for seedling establishment.
6. Growth of slash pine exceeded that of loblolly pine following drainage of all plots inundated from 2 to 8 weeks.
7. Trees in several plots grew twice as much from October 11 to November 13 as in the 133 days prior to October 11.

U. Ga., Athens, Ga.

Carvell, K. L., and Tryon, E. H. THE EFFECT OF ENVIRONMENTAL FACTORS ON THE ABUNDANCE OF OAK REGENERATION BENEATH MATURE OAK STANDS. Forest Sci. 7: 98-105. 1961.

The scarcity of oak regeneration beneath previously unmanaged, mature oak stands is of grave concern to the forest manager, since oak reproduction cannot be obtained quickly, and the composition of the new stand is largely predetermined by the composition of the understory at the time the overhead canopy is removed. To determine those environmental factors which are responsible for this lack of regeneration beneath many mature oak stands, 59 study areas were established and various environmental factors measured.

This analysis indicates that the ability of oak regeneration to persist on a specific site is more closely related to environmental conditions than is its ability to become established.

The percent sunlight reaching the forest floor shows a significant positive correlation with the amount of oak regeneration. The regression equation relating oak regeneration to percent sunlight indicates that the greater the percent of sunlight, the larger the number of oak seedlings. When percent sunlight is combined with exposure an even closer correlation is obtained. This suggests that oak seedlings can persist not only in the more open stands, typical of dry exposures, but can be brought in and maintained on moist exposures where regular thinnings have been used to provide adequate light.

Stand history or degree of disturbance during the past 20 years was found to be very closely correlated with the amount of oak regeneration. Stands which have been thinned, grazed, or lightly burned during the past two decades generally possess a greater reservoir of oak regeneration than undisturbed stands.

The abundance of oak regeneration shows no direct correlation with increasing slope position, i. e. from bottom to ridgetop. The largest number of oaks occurred on the middle-third slope positions, and decreased on the upper-third slopes and ridges.

On the drier exposures (southeastern, southern, southwestern, western, and northwestern) oaks can be maintained with little difficulty since here oak types form the climax or long-range subclimax. On moister exposures, care must be used to provide regular crown openings. A series of thinnings during the last years of the rotation is suggested to provide sufficient sunlight for seedling establishment and survival.

W. Va. U., Agr. Expt. Sta., Morgantown, W. Va.

Barrett, J. W. RESPONSE OF 55-YEAR-OLD LODGEPOLE PINE TO THINNING. Pacific Northwest Forest and Range Expt. Sta. Res. Note 206, 8 pp. 1961.

An unmanaged stand of lodgepole pine (*Pinus contorta*) in central Oregon responded exceptionally well to a first thinning at the comparatively late age of 55 years. Diameter growth was stimulated markedly, mortality was reduced, and stems grew more rapidly into merchantable size classes. Thinning to a spacing of 12 by 12 feet at age 55 produced higher yields and merchantable volumes at age 77 than thinning to a spacing of 16 by 16 feet. During this 22-year period, understory vegetation changed from a sparse condition to a good stand of grasses in the heavily thinned stand.

These trends suggest that thinning on some lodgepole pine sited may increase both timber and forage production.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Godman, R. M., and Krefting, L. W. FACTORS IMPORTANT TO YELLOW BIRCH ESTABLISHMENT IN UPPER MICHIGAN. Ecology 41: 18-28. 1960.

Although adequate seed crops occur frequently, the proportion of yellow birch seedlings is generally lower in second-growth stands than before cutting. Because it is the most valuable species in the type, the economic return from management should be higher if the proportion of yellow birch could be increased. A study was begun in the Upper Peninsula of Michigan, near the western limits of the natural range, to determine the effect of seedbed condition and the relative importance of home environmental conditions on yellow birch in this area.

Results of this preliminary study indicate that scarification exposing mineral soil on 50 percent or more of the seedbed will increase the proportion of yellow birch in northern hardwood stands. A method of partial cutting, in conjunction with snow-free logging or mechanical scarification, would favor the environmental conditions required by this species. Removal of the overstory canopy to let through approximately 50 percent of full sunlight appears to be the most favorable for establishing the seedlings and for providing enough shade to retard brush and weed competition and reduce the influence of frost.

Recommended silviculture in the type now includes planned salvage cuts 3 to 5 years after the initial cutting. These cuts would gradually increase the amount of light for maintaining growth on established reproduction. Release cuttings may be necessary to free the most promising trees from overhead competition and to provide growing space for rapid stem development of this valuable species.

Lakes State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Tryon, E. H., Carvell, K. L., and Berthy, H. P. PLANTING CONIFEROUS FORESTS IN WEST VIRGINIA. W. Va. U. Agr. Expt. Sta. C. 109, 50 pp. 1961.

Although 10 million acres, or two-thirds of West Virginia, are already in forests, another million acres should be reforested. Young stands of valuable trees are starting to grow on a portion of the million acres. Seeds of such trees as yellow-poplar, white ash, oaks, black cherry, pines, and spruces have been blown or carried into nearby fields. Upon germinating they produce seedlings which will develop into valuable forest trees. Gradually these fields are becoming satisfactorily stocked.

More than half of the million acres will not become reforested naturally with desirable forest trees for many years because of lack of a seed source, or because the seed source is from inferior trees such as crab apple, fire cherry, and hawthorn. This half million acres should be planted for the purpose of growing a forest crop.

Planting old, worn-out fields that are not reseeded will result in a potentially valuable timber crop and at the same time improve the soil fertility. Growing trees on such land will help prevent erosion, keep the soil from washing away and silting the streams, and will contribute to a continuous desirable water supply throughout the year.

Suitable kinds of trees to plant, planting methods, handling planting stock, planting season, and site preparation are discussed in hopes that more successful tree plantings can be established in West Virginia.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.



How to make the best use of overflow bottomland sites always has been a problem. The soils on those sites are usually fertile but seasonal flooding, poor drainage, or both, often make farming uncertain and expensive. The present trend is toward clearing more bottomland for agriculture. Owners of such land should consider growing timber on it so as to take advantage of the remarkable tree growth on such sites.

There are five basic steps bottomland forest owners must take to make their forests productive.

1. Protect the Forest. Forests must be protected from fire and grazing.

2. Appraise the Wood land. Answers are needed to the following questions: (1) What tree species are best suited to the bottomland sites? What growth rates and yields can be expected? (2) What is the conditions of the timber at present? (3) What is the flooding situation; i. e., how often does the land flood and what is the severity and duration of the floods?

3. Study Marketing and Economics. A vital part of good business is to learn which timber products can be sold and at what price. Determine whether there is an operable cut. Compare prices of trees sold on the stump with prices for logs and decide how to market the forest products--as stumpage or as logs or other products.

4. Mark Timber for Harvesting. It is important to know which trees should be cut, which ones should be left to grow, and which trees should be killed because they are worthless and occupy space needed for desirable trees.

5. Sustained Yield. After the forest has been rehabilitated and is in thrifty condition, the subsequent treatment will depend on which system of management is appropriate for the stand. This should be prescribed by a professional forester. If the proper system is used, there will be: (1) Maximum production of high-quality products; (2) continuous adequate establishment and growth of desirable trees in places where trees are harvested; (3) sustained yield of forest products; and (4) soil stability and a good wildlife habitat.

Central State Forest Expt. Sta., FS, USDA, Carbondale, Ill.

Stransky, J. J. WEED CONTROL, SOIL MOISTURE, AND LOBLOLLY PINE SEEDLING BEHAVIOR. J. Forestry 59: 282-284, 289-290. 1961.

Low survival of planted pines during dry weather emphasized the need, in East Texas, of controlling vegetation that competes with seedlings for soil moisture.

In a critical drought, those scalping, mulching, and chemical treatments that best controlled weeds and grasses retained highest soil-moisture content and produced best pine survival.

The effect of the pine-needle mulch was chiefly to smother competing vegetation. Mulch probably also increased moisture through greater infiltration, and contributed some nutrients that stimulated growth on plots where scalping had removed topsoil.

In view of the frequent droughts in East Texas, it appears unwise to plant pine seedlings without some form of site preparation.

The higher moisture levels in August on scalp-mulch and Vapam-mulch plots are consistent with the relative condition of these treatments in early June, and may be a residual effect of higher early season moisture levels.

Ten months after planting, seedling survival percentages ranked as follows: scalp 92, scalp-mulch 90, Vapam-mulch 83, natural-mulch 70, Vapam 57, and natural 30.

Nacogdoches Res. Cent., Southern Forest Expt. Sta., FS, USDA, Nacogdoches, Tex.

Ferguson, E. R. EFFECTS OF PRESCRIBED FIRES ON UNDERSTORY STEMS IN PINE-HARDWOOD STANDS OF TEXAS. J. Forestry 59: 356-359. 1961.

Replicated prescribed burns were made at four seasons, in 3 years, in an East Texas forest containing an immature loblolly-short-leaf pine overstory and a fairly heavy hardwood understory. Effects were noted on small stems (less than 4.5 inches in diameter) of sweetgum, post and red oak, and pine.

Although the behavior of the individual fires varied, results were fairly consistent, indicating that general limits can be set on expectations from prescribed burning for hardwood control.

Proportionally more hardwood than pine stems were killed-back, but most of the damaged pine stems were killed, while about 90 percent of the injured hardwoods resprouted from their rootstocks.

Sweetgum stems proved more susceptible to fire injury than oak stems--almost twice as many sweetgums as oaks were killed-back and over three times as many were completely killed.

Growing-season fires reduced the hardwood understory more and killed more pine than fires during the dormant season.

One- and 2-inch stems of all species were more effectively controlled than larger stems.

Nacogdoches Res. Cent., Southern Forest Expt. Sta., FS, USDA, Nacogdoches, Tex.

Miller, W. D. DEVELOPMENT OF PLANTED LOBLOLLY PINE IN A POISONED UPLAND HARDWOOD STAND OF THE LOWER PIEDMONT. J. Forestry 59: 184-186. 1961.

A replicated and randomized poisoning and planting experiment on the Hill Demonstration Forest, Durham County, N. C., with two formulations of phenox-yacetic acid, three concentrations, and two methods of application has resulted, in nine growing seasons, in the conversion of a moderately dense upland hardwood stand to an established loblolly pine stand of 875 stems per acre.

The following general conclusions can be drawn from this experiment: (1) Basal area provided the most striking contrast between the development of loblolly on treated plots and that on check plots. (2) Treated plots had only one-third as many hardwood stems in the 1-to-3-inch d.b.h. class as were found on check plots, but a substantially greater number of hardwoods 1/2-inch d.b.h. and smaller. Despite the abundance of hardwood regrowth, pine was clearly dominant. (3) Pines in vigorous condition were twice as numerous on the treated as on the check plots. (4) Volume production indexes showed a 3-to-1 ratio in favor of the treated plots.

School Forestry, N. C. State Col., Raleigh, N. C.

Arend, J. L., and Roe, E. I. RELEASING CONIFERS IN THE LAKE STATES WITH CHEMICALS. U.S. Dept. Agr., Forest Serv., Agr. Hbk. 185, 22 pp. 1961.

Brush and low-value hardwoods are often obstacles to the satisfactory establishment and growth of conifers in both planted and natural stands. Once established, most conifers in the Lake States need full sunlight for best growth. Brush, undesirable trees, and other competing vegetation must be kept from overtopping these more valuable trees. The job of keeping such competitors from interfering with the satisfactory development of conifers is called release.

The principal types of release needed in the Lake States region and how they are accomplished with the aid of chemical herbicides are described. Detailed information on the types of herbicides used, and on techniques of application suitable for various kinds and conditions of competition is given.

FS, USDA, Inform. Div., Washington 25, D. C.

MacConnell, W. P., and Bond, R. S. APPLICATION OF HERBICIDES WITH MIST BLOWERS: A PROMISING METHOD FOR RELEASING CONIFERS. J. Forestry 59: 427-432. 1961.

Herbicides may be applied with mist blowers to control hardwoods at costs which compare favorably with aerial applications. Some of the disadvantages of aerial application can be overcome by this technique; notably, the problems of drift, interception of spray by the overstory, lack of selectivity, and the requirement that a fairly large unit be done at one time. Both truck-mounted and back-pack mist blowers can be used to apply the spray material with good results. Spray mixtures of the type used from the air gave satisfactory hardwood control when applied from the ground by mist blower. An effective and economical field technique of using back-pack mist blowers was developed. A large blower was successfully operated from a truck on a woods road, achieving penetration into the stand up to 150 feet from the point of spray application. This machine should probably be operated from a tractor to gain greater mobility in areas not accessible by truck. Back-pack mist blower operation is hot, unpleasant work; operation of the larger machine is easier. The larger machine will control hardwoods 70 feet in height; whereas, the practical maximum for the smaller machine is 30 feet. Hardwood control was successfully accomplished under a wide range of mixed forest conditions with applications made in August.

Sixty percent or more of the hardwood trees were severely damaged or killed in the treated areas. Damage to softwoods was negligible at this season of the year. Norway spruce and eastern hemlock were more susceptible to damage than eastern white pine. Ground application of herbicides by mist blowers to control hardwoods should extend the use of chemical foliage sprays to areas where aerial spraying is not possible or desirable.

U. Mass., Amherst, Mass.

True, R. P., Barnett, H. L., Dorsey, C. K., and Leach, J. G. OAK WILT IN WEST VIRGINIA. W. Va. U. Agr. Expt. Sta., B. 448 T. 119 pp. 1960.

Since oaks make up over half of the standing timber in the State of West Virginia, oak wilt is considered a very dangerous disease to the timber industry. This bulletin is designed to present, in one place, information concerning the history of this disease, its nature, cause, present importance, and the prospects for its control.

Research scientists at the West Virginia University Agricultural Experiment Station have been investigating oak wilt since it was first found in West Virginia in 1951. This bulletin deals in part with previously unpublished information from West Virginia, and from more than 200 published articles concerning oak wilt and related subjects.

Oak wilt is known to have caused serious losses among oaks of the red-oak group. Today it threatens all oak species growing in the 18 States where its presence is recognized. The erratic but generally slow spread of this disease has given time for a comprehensive research program to develop in several states and in two regional experiment stations of the United States Forest Service. Research findings and their application in well-managed control programs may make it possible to prevent disastrous losses if control measures



are wisely chosen, if control programs are adequately supported, and if such programs are continued without interruption while the threat of oak wilt exists.

W. Va. U. Agr. Expt. Sta., Morgantown, W. Va.

Craighead, F. C., and Nelson, J. C. OAK WILT IN PENNSYLVANIA. J. Forestry 58: 872-881. 1960.

Present evidence based on the typical wilting symptoms in red, scarlet, and black oaks indicates that oak wilt in Pennsylvania is an endemic disease generally distributed in the mountains of the south central portion of the State and of more scattered occurrence in some outlying counties. The most serious aspect of the disease is the mortality it causes among residual trees after logging operations.

The disease is normally recognized in red, black, and scarlet oaks by the wilting of the foliage over the entire tree. The disease occurs commonly in white and chestnut oaks, where it does not produce practicably recognizable foliar symptoms. The number of infected trees in these species may be much greater than among those species that show "typical" symptoms. This condition is disregarded in present survey and control practices. American chestnut sprouts also may be harboring the disease.

The timber killed by this disease over the past 7 years is of little consequence, approximately 1,073,000 board feet with a stumpage value of \$16,000. Nevertheless, approximately \$50,000 to \$60,000 is spent each year on oak wilt control in Pennsylvania.

It is presently accepted on the basis of much circumstantial evidence that the disease spreads locally on the perimeter of centers primarily through root-grafts; also that overland transmission of the disease takes place by animals carrying the spores from fruiting bodies on dying trees to wounds on healthy trees. Recently it has been demonstrated that the transfer of the inoculum from wound exudates on diseased trees to wounds on healthy trees. This may be the most important means of spread and might explain the increase in wilting trees during wet seasons.

Jr. Author, Pa. Dept. Forests and Waters, Harrisburg, Pa.

Abbott, H. G. WHITE PINE SEED CONSUMPTION BY SMALL MAMMALS. J. Forestry 59: 197-201. 1961.

Laboratory experiments with caged white-footed mice, boreal red-back voles, and meadow voles indicated their potential as consumers of eastern white pine seed. White-footed mice ate an average of 109 seeds per day; red-back voles, 97; and meadow voles, 139 seeds.

White pine seed exposed in four feeders placed on a one-half acre plot in an abandoned juniper pasture were eaten avidly by small mammals. Fifteen pounds and fifteen ounces of seed (373,065 seeds) were eaten or removed from the feeders in a 68-day period from October 3 to December 9.

The species and number of animals responsible for destroying the exposed seed were determined by trapping. Fourteen white-footed mice and eight red-back voles were caught.

An analysis of the empty seed coats left in the feeders at the end of each day showed that approximately one-half the seeds were eaten, the other half presumably stored.

White-footed mice were credited with destroying 260 seeds per animal, daily, compared to 232 seeds destroyed by each red-back vole.

The results show that mice and voles, which constitute only one segment of the small mammal population in the forest, are capable of destroying large numbers of eastern white pine seed. These animals, when occurring in substantial numbers, can consume quantities of pine seed far in excess of those amounts which it is economically feasible to sow in direct seeding work. They also have

a seed-eating potential so great as to be capable of eating and storing all naturally disseminated seed except that which is undetected in their feeding activities.

Dept. Forestry and Wildlife, U. Mass., Amherst, Mass.

English, L. L. ILLINOIS TREES AND SHRUBS: THEIR INSECT ENEMIES. Ill. Natural Hist. Survey C. 47, 92 pp. 1958.

An illustrated manual on insect enemies of Illinois trees and shrubs and their control.

Ill. Natural Hist. Survey, Urbana, Ill.

### Fruit and Nut Crops

Cain, J. C. PRUNING CHERRIES FOR MACHINE HARVESTING. N. Y. State Agr. Expt. Sta. Farm Res. 24(4): 4-5. 1960.

Recent progress in the mechanical harvesting of cherries has indicated considerable reduction in cost of harvesting in comparison with conventional harvesting methods. These developments have largely been centered around the mechanical aspects of the shaking machine and catching equipment. This work has been done with conventional orchard trees with little or no attention to horticultural aspects such as special pruning practices to improve harvesting efficiency and reduce branch injury or to the effect of such practice on production.

In the spring of 1960, a number of 8 to 10 year old trees were pruned in an experimental orchard at Geneva and in a nearby commercial orchard with particular attention to the following points: (1) Clearance beneath the tree for catching equipment; (2) minimum number of branches to be shaken per tree; and (3) orientation of branches for shaking from one direction.

Many orchard management practices may have to be modified in the future to meet the economic demand for more efficient fruit production. Many of these cannot be done in a single season. The best time to modify and control tree structure and branch arrangement is during the first 2 or 3 years in the orchard. The older the trees, the more drastic must be the pruning to achieve a radically different branch arrangement and the longer it will take for the tree to recover its bearing capacity. Some modified pruning will probably have to be done in most orchards for efficient utilization of mechanical harvesting equipment.

The following are some of the more important points to keep in mind for pruning cherry trees which are to be harvested mechanically: (1) Clearance beneath the tree for catching equipment. This should be at least 2 feet at the trunk and 4 feet at the periphery of the tree for equipment currently in use. (2) Visibility of the point of attachment of shaking arm from operator's position. (3) Clear area on branch for attachment of shaking arm. (4) Minimum number of branches per tree, preferably not over three. (5) Orientation of "fan" of branches to be shaken from one position of the shaking machine. And (6) removal of all branches that cannot be profitably shaken. Branches usually fall into this category which will bear less than about 15 pounds of fruit unless they will develop into about one-third or more of the future tree, and branches that have an undesirable angle to the shaking arm.

N. Y. State Agr. Expt. Sta., Geneva, N. Y.

Johnston, S., and Moulton, J. E. INVESTIGATIONS IN APRICOT CULTURE IN MICHIGAN. Mich. Agr. Expt. Sta. Sp. B. 434, 20 pp. 1961.

A culture and care bulletin for growing apricots in Michigan is presented. Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Stiles, W. C., and Ritter, C. M. PHOTOSYNTHETIC AND GROWTH RESPONSES OF APPLE TREES TO GROWTH REGULATING CHEMICALS. Pa. Agr. Expt. Sta. B. 673, 14 pp. 1960.

The effects of naphthaleneacetic acid (NAA) and 2,4,5-trichlorophenoxypropionic acid (2,4,5-TP) on apparent photosynthesis, color, dry weight and size of leaves, and length of shoot growth of apple trees were studied during 1956 and 1957. A modified eudiometric technique was developed for measuring apparent photosynthesis in terms of gas evolution by apple leaves. By means of this technique, it was possible to apply growth regulators to intact leaves and study gas evolution under controlled light, temperature, and carbon dioxide supply conditions in the laboratory.

Different methods of experimentation, varieties and ages of trees, and timings and concentrations of the growth regulators were employed during the 2 years. The results were summarized as follows: (1) NAA at commercial concentrations (10 to 20 p.p.m.) did not significantly alter the rate of apparent photosynthesis per square centimeter of leaf area, leaf color, or dry weight per square centimeter of leaf area; (2) NAA at 10 and 20 p.p.m. significantly reduced the photosynthetic area of 5-year-old Rome Beauty apple trees by effecting reductions in average leaf size and total length of terminal shoot growth; (3) NAA at 10 and 20 p.p.m. effected a pronounced inhibition of first wave shoot extension when applied as late as 3 weeks after full bloom; (4) 2,4,5-TP at 10 and 20 p.p.m. effected less than a 10-percent change in rate of apparent photosynthesis. Such changes are not considered to be of practical importance; (5) 2,4,5-TP at concentrations up to 40 p.p.m. did not significantly alter leaf reflectance; and (6) 2,4,5-TP at concentrations up to 40 p.p.m. effected a reduction in dry weight per square centimeter of leaf area.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Larsen, R. P. CHEMICAL DEFOLIATION OF CONCORD GRAPES PRIOR TO HARVEST. Mich. State U. Q. B. 43(4): 830-837. 1961.

During the period 1957 through 1960, various defoliant chemicals were applied to Concord grape vines approximately 1 week prior to harvest. Observations included degree of defoliation; condition, drop and soluble solids of the fruit; and vigor and winter hardiness of the canes.

Considerable variation was found in degree of defoliation and berry drop from the use of different chemicals. Magnesium chlorate and sodium chlorate were the most promising of the defoliants tried. The amount of berry drop paralleled the degree of defoliation. The chemicals as used had no significant effects on the soluble solids of the fruit. Endothal did cause off-flavor of the fruit. No material, except Diquat, had any visible effect on vine growth or susceptibility of the canes to winter injury.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Crops Research Division. MUSCADINE GRAPES: A FRUIT FOR THE SOUTH. U.S. Dept. Agr. Farm. B. 2157, 16 pp. 1961.

Muscadine grapes are prized as fresh fruit in the region where they are grown. They also are used for unfermented juice, pies, jellies, sauces, and wines. Muscadine wines have a distinctive flavor, and are sold primarily to a specialty trade. Fruit marketed fresh generally is sold locally, because flavor and aroma deteriorate rapidly under usual methods of handling.

This fruit is a favorite for home planting because it is seldom seriously affected by diseases or insects, and control measures are seldom needed.



Yields vary widely. Some of the factors that affect yields are variety, vineyard care, pruning, fertilization, and weather. Production in commercial vineyards generally is between 2 and 4 tons per acre. Many vines yield more than a bushel each.

This is a complete culture and care bulletin on Muscadine grapes.

ARS, USDA, Inform. Div., Washington 25, D. C.

Hinrichs, H. A. THE RELATIONSHIP OF NATIVE PECAN TREE SPACING TO YIELD. Okla. Agr. Expt. Sta. B. B-574, 11 pp. 1961.

Previous research at Oklahoma has shown that reducing the stand of native pecan trees will increase production. A simple, rapid method was needed to determine when and how much to thin these trees to obtain the highest possible yield per acre. Research aimed at finding such a method was started in 1951 by the Oklahoma Agricultural Experiment Station at its Pecan Research Station near Sparks, in central Oklahoma. The study was continued over a 7-year period from 1953 through 1959.

The number of square feet of cross-sectional trunk area per acre is a reliable method for determining when crowding exists. It was found that the maximum production of pecans per acre occurred at 30 square feet of cross-sectional trunk area per acre. When an acre has more than 34 square feet of cross-sectional trunk area, the trees need to be thinned.

A method is given for computing trunk area per acre to determine when crowding exists and how much pecan trees should be thinned.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Luepschen, N. S. FIRE BLIGHT CONTROL WITH STREPTOMYCIN, AS INFLUENCED BY TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS AND BY ADJUVANTS ADDED TO SPRAYS. Cornell U. Agr. Expt. Sta. Mem. 375, 39 pp. 1961.

The fire blight disease of pomaceous fruits, caused by the bacterium, (*Erwinia amylovora* (Burrill) Winslow *et al.*), is of great importance in New York State. It is the most destructive disease of the pear and can cause sizable economic losses to a number of apple varieties.

With the introduction of antibiotics into the field of agriculture, streptomycin has been successfully used in the control of bacterial diseases of plants and has also been applied to the task of controlling fire blight.

The influence of different environmental factors on the control of fire blight under the conditions prevailing in New York State was determined. An attempt was made to modify the spray mixture to improve control and particularly to enhance penetration into the tissues.

Controlled temperature chamber and green house studies with dwarf pear trees showed that blossom blight control was possible at 60°, 65°, and 70° F., with protective streptomycin sprays before inoculation and with a 24-hour post-inoculation spray, while the temperature at the time of spraying did not greatly affect the degree of control. In a comparison with 2-6-100 Bordeaux mixture under high and low temperature conditions, streptomycin proved to be superior in blossom blight control. A simulated rain experiment showed that while streptomycin spray deposits on the blossom surfaces contribute to blight control, more than half of the protection is from the absorption of the antibiotic.

Young apple trees were studied to find suitable adjuvants that would increase streptomycin penetration as evidenced by shoot blight control. The addition of glycerol or Triton B-1956, a surface active agent, to spray solutions appeared the most promising.

Field control of pear blossom blight with 2 and 3 spray applications at 100 p.p.m. was excellent in the spring of 1959 in a Bosc and Gorham pear orchard. At the same time control in a Clapp's Favorite pear orchard, where 2 sprays were applied with a speed sprayer at 2 X concentration, was not significant.

Considering environmental factors that may influence fire blight control with streptomycin, it is felt that high humidity may prove to be of greater importance than temperature in facilitating absorption.

Streptomycin nitrate was compared with the sulfate form in controlling pear blossom blight. The nitrate form appeared slightly superior to the sulfate form.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Oatman, E. R. WISCONSIN APPLE INSECTS. Wisc. Agr. Expt. Sta. B. 548, 29 pp. 1960.

More than 100 species of insects and mites infest apple trees under natural conditions in Wisconsin. Fortunately, less than 10 are serious pests in commercial orchards. Three insects--apple maggot, plum curculio, and codling moth--destroy practically 100 percent of the fruit unless trees are sprayed.

With DDT and more recent insecticides, we can produce quality apples, 95 to 100 percent free of insect injury. These advances in insect and mite control have produced new and complicated problems. The more serious ones include: The appearance of formerly obscure species as major pests, insecticide residues, and insect resistance to previously effective insecticides.

Because of these factors, control programs have become increasingly complicated and expensive. The successful grower must recognize insect and mite injury and must know the fundamental aspects of their life histories for effective and economic control.

Major insect and mite pests are considered in detail. Minor pests are briefly described, either because of past sporadic injury or because of potential future destructiveness.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

Brooks, A. N., and Kelsheimer, E. G. INSECTS AND DISEASES AFFECTING STRAWBERRIES. Fla. Agr. Expt. Sta. B. 629, 35 pp. 1961.

Insects and disease of strawberries in Florida are illustrated and described. Recommended methods of control are given.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Eadie, W. R. CONTROL OF WILDLIFE DAMAGE IN ORCHARDS. N. Y. State Col. Agr., Cornell Ext. B. 1055, 16 pp. 1961.

Several kinds of wildlife may damage orchards in New York State and create serious economic problems for fruit growers. Meadow mice live in every sod orchard and are a constant threat to the life and health of trees of all ages. Pine mice are a special problem to growers in some areas of southeastern New York. In years when they are abundant, cottontail rabbits may damage trees badly. Deer are now numerous in many agricultural areas and often harm trees by browsing or thrashing them.

Recommended methods to reduce or prevent damage by the four types of wildlife are given.

Coop. Ext. Serv., N. Y. State Col. Agr., Cornell U., Ithaca, N. Y.

SITUATION--Acreage expanded rapidly until 1926, then declined by over half. The decrease was less severe in the major producing areas and for the principal apricot varieties.

Yield doubled since 1920-1929 to almost 5 tons per bearing acre. Yield varied widely from year-to-year and among districts and varieties.

Production increased sharply during 1920-1939 and then decreased by a quarter to an average of 185,000 tons maintained since 1940.

Canning has become the major outlet. The quantity canned rose from a quarter of the crop in 1915-1929 to two-thirds since 1955.

Drying reached a peak of 168,000 tons in the 1930's, then decreased to 46,000 tons. Drying declined from 68 to 25 percent of sales.

Fresh sales increased gradually to almost 25,000 tons in 1944-50, then declined sharply to 11,000 tons in 1955-59. Usually half to two-thirds of these sales are made within the state.

Exports represented 35 to 40 percent of the prewar crop. With curtailed shipments of canned and dried apricots after the war, exports dropped to 10 percent of the average crop in 1945-59.

Grower prices were highest for interstate fresh shipments and lowest for cannery sales. The average seems to be determined chiefly by consumer purchasing power, and to a lesser extent by annual production.

OUTLOOK--New acreage coming into bearing in the next few years will about offset tree removals. Bearing acreage will become still more concentrated in the major districts.

A further small rise in yield, 10 percent, seems likely by 1965--provided good cultural practices, now used, are not abandoned.

Some increase in production is expected. Large annual variations will continue, as in the past, because of fluctuations in yield.

Larger quantities will be canned. As much as 75 percent of the crop may go to canners by the mid-1960's. Drying outlet will become even less important, if canning expands as expected. Drying may decline to 20 percent of the crop. The recent downward trend of fresh sale is not expected to continue. However, a large increase also seems unlikely.

Exports are likely to continue at about present level (far below prewar quantities), especially for canned and dried apricots. Fresh shipments may increase but not sufficiently to affect the over-all picture greatly.

The outlook is for growers prices at recent averages, or slightly above, -- provided consumer purchasing power continues to climb. Prices should not be depressed unduly except in years when bumper crops are produced.

Calif. Agr. Expt. Sta., Davis, Calif.

SITUATION--The canned ripe olives consumed in the United States are all from California. Much of the olive oil consumed and certain other products, such as Spanish green olives, are imported, --largely from the Mediterranean Basin.

Acreage in California until 1920 expanded rapidly, thereafter remaining at some 31,000 acres. During the past 40 years, yield increased steadily to the average of 1.7 tons per acre maintained since 1945. Annual production increased correspondingly, from 8,200 tons in 1910-14 to 46,000 tons in the past 15 years.

Farm prices reached a high level during the 1940's when war conditions drastically reduced olive oil imports. They declined immediately thereafter to an average of \$200 per ton since 1950. They averaged \$60 per ton for the 1930-40 period.



Marketing controls have been used to improve returns to the industry. At present the major reliance is on advertising to promote sales of canned ripe olives and on a stabilization plan to correlate supply with market demand.

OUTLOOK--Production is likely to increase in the immediate future, but only to a limited extent. Tree removal is expected to approximate new acreage coming into bearing. Yields somewhat above the present level are indicated--provided the good cultural practices now employed continue.

The present level farm price probably will be maintained or exceeded--if consumer purchasing power continues to climb at or near the rate of recent years. Prices for canning, crushing, and other processing should continue at present relationships since the proportions of the crop entering the various outlets are not expected to change.

Calif. Agr. Expt., Davis, Calif.

Hardy, B. WHY SOME FRUIT GROWERS MAKE MONEY--AND OTHERS DON'T. Farm J. Eastern Ed. pp. 27. Aug. 1961.

Why does one orchardist end up with a profit and his neighbor lose his shirt? To find out, Cornell economists D. G. Williams, B. A. Curvey, and C. D. Kearl surveyed pear-growing on 35 New York farms that averaged 90 acres each in tree fruits, 9 acres of them in pears.

Incomes on pears ranged from a loss of \$104 an acre to a net profit of \$540 an acre!

Three farmers had exactly 16 acres each in pears; all lived in the same general area. But the difference in their profits was astounding!

	Farmer A	Farmer B	Farmer C
Acres in pears .....	16	16	16
Price/bu.....	\$2.37	\$2.01	\$2.07
Growing cost/acre.....	\$139	\$99	\$181
Harvest cost/bu. ....	40¢	40¢	34¢
Net yield/acre.....	221	60	44
Net return .....	\$4,734	-\$48	-\$1,675

It's plain that yields determine profits. Farmer A would have made a good profit even at much lower prices. His gross was \$323.77 per acre to C's \$91.08.

Here are averages for all 35 farmers. Growing costs: Labor, \$51 an acre including the farmer's labor; sprays and dusts, \$28; land, \$25; power and equipment \$20; fertilizer and lime, \$13; other (bees, custom work, interest, overhead), \$14. Total costs, \$151 an acre. Harvesting costs: Labor, \$54 an acre (37 hours); power, equipment, containers, and such, \$11. Total, \$65 an acre. Prices: \$2.12 a bushel; \$356 gross per acre; net profit, \$140 an acre.

The break-even point for farmers in the survey was 105 bushels an acre, including the farmer's own time. The two with the biggest profits made 350 bushels an acre; the six who lost money had less than 117 bushels.

Carl Younglove (Farmer A) gives the following comments on his successful pear growing project:

1. Don't over-prune as too much new growth increases blight. (He does little more than cut out deadwood and suckers and tops overtall trees.)
2. Don't over-fertilize as too much invites blight. (He uses ammonium nitrate only and no more than 2 pounds per tree.)
3. Don't over-spray. (He sprays five times and uses no dormant sprays.)
4. Don't under-pollinate. (He uses Boscs as pollinators for Bartletts.)

5. Don't under-sell. Grow enough to interest buyers, make sure they're top quality, and you should receive a better price.

Staff writer for Farm Journal, Washington Square, Philadelphia 5, Pa.

Wennergren, E. B., and Lee, W. A. ECONOMIC ASPECTS OF BRUISING IN THE APPLE-PROCESSING INDUSTRY. Pa. Agr. Expt. Sta. B. 675, 20 pp. 1961.

The purposes of this study were: (1) To determine the magnitude of bruising occurring in movement of apples through harvesting and processing channels; and (2) to investigate the factors related to the amount of total and meaningful bruising.

Data for analysis were obtained from field studies conducted in cooperation with the Adams County Fruit Growers Association during the 1956-58 crop seasons. Magnitude of bruising was measured by: (1) Total numbers of bruises per apple, and (2) percentages of bruised flesh of total apple weight. These measurements point for apples prior to conversion into the final processed product; the amount of bruising at this point represents the accumulation of all bruising inflicted in movement from the tree through the processing plant.

Factors related to amount of total bruising were classified as: (1) Characteristics of the apple, such as maturity, size, and variety; and (2) characteristics of the handling process, such as location, design of sizing grader, type of picking bag used, method of paying pickers, and grower differences. Three varieties of apples were compared in these trials.

The factors related to the amount of meaningful bruising were investigated by a controlled experiment in which plant trimmers were utilized. Sizes, numbers, and ages of bruises were experimentally controlled. Trimmers from a plant making apple slices and from a plant making apple sauce were used to remove those bruises which they considered detrimental to the final product. Two varieties of apples were used in these tests.

The major findings of this study were:

1. Bruised flesh represented 2.79 percent of the total apple weight. Total bruises averaged 2861 per 100 pounds of apples.
2. In slice production, labor represented 85 percent of the material and labor cost resulting from bruising. In sauce production, labor costs amounted to 67 percent.
3. Maturity, size, and variety of apple contributed significantly to the amount of total bruising.
4. Movement of apples from the orchard through the processing plant inflicted an average of 9.8 bruises per apple. Each location contributed significantly to the total number of bruises.
5. Plant locations contributed the greatest number and most severe bruises.
6. Grading apples prior to entering cold storage increased the number of bruises 84 percent. Movement of apples into cold storage without grading increased the number of bruises 25 percent.
7. Significant differences were found in the amount of bruising inflicted by different growers. These differences were at low levels of bruising.
8. More bruises occurred with use of the "Pennsylvania" canvas picking bag than with the modified, rigid side container.
9. Trimmers removed 69.1 percent of the total bruises in the production of apple slices and 21.0 percent in the production of apple sauce.
10. More bruises were removed as age of bruise increased in the production of both sauce and slices. However, trimmers removed 63.4 percent of the bruises less than 1 hour old in the production of slices and 13.8 percent in the production of apple sauce.
11. More large than small bruises were removed in the production of both products.

12. Trimmers removed a constant percentage of bruises as the number per apple increased in the production of apple slices, but removed an increasing percentage in the production of apple sauce.
13. More bruises were removed from York than from Golden Delicious in the production of both products.
14. Significant differences were found in the amount of bruising removed by individual trimmers.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

### Field Crops

Tharp, W. H., Thomas, R. O., Walhood, V. T., and Carns, H. R. EFFECT OF COTTON DEFOLIATION ON YIELD AND QUALITY. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 46, 24 pp. 1961.

The effect of time of defoliation on cotton yield and properties of fiber and seed, determined from 11 tests in 5 States over a 3-year period, was primarily dependent upon the relative maturity of the crop at the time of defoliation.

Although there was considerable variation between tests, results of these studies show:

1. Defoliation has no deleterious influence on bolls open or those fully mature and as yet unopened at the time of application.
2. Any boll less than 36 days old at time of defoliation may suffer loss in weight of fiber and seed and in quality of products; particularly oil content of seed and fineness of fibers. This "36 days of age" is an average value. Where boll periods are short, the safe time for defoliant application will be earlier, about 32 days; and where long, as is usually the case in the irrigated Far West, the safe period will be about 42 days.
3. Defoliation prior to this safe period resulted in loss in yield and in quality of lint and seed in the following order: (1) Yield of seed cotton--reduced; (2) oil content of seed--reduced; (3) fiber fineness--increased; (4) viability of seed--reduced; (5) pressley strength of fibers--occasionally increased; (6) spinning value of yarns (increase in neps and waste, and decrease in yarn appearance grade but no change in skein strength)--reduced; (7) upper half mean length of fibers--no change; and (8) protein content of seed--no change.
4. The net loss in yield and quality of the total crop depended wholly on the proportion of the crop that was immature at the time of defoliation.

ARS, USDA, Inform. Div., Washington 25, D. C.

Boyd, F. T., Green, V. E., Jr., and Chapman, H. L., Jr. PRODUCTION OF SORGHUM FORAGE AND GRAIN IN SOUTH FLORIDA. Fla. Agr. Expt. Sta. B. 628, 28 pp. 1961.

A culture and care bulletin on the production of sorghum forage and grain in South Florida is presented. The following general recommendations are given:

1. Provide good water control. For highest sorghum yields, facilities for irrigation and drainage should be established to allow for rapid surface run-off and a water table maintained at 24 to 36 inches below the soil surface after stand is obtained.
2. Plow crop area well in advance of planting. Plow or disk plant residues beneath the soil surface, but exercise care in plowing sandy soils to prevent bringing white sand from the subsoil to the surface.
3. Broadcast lime and fertilizers in amounts indicated by soil tests and disk well into the soil before planting.



4. Drill treated seed at rates of 10 to 15 pounds per acre, depending on size and quality of the seed. This rate is sufficient to give 10 plants per foot of row. Rows spaced alternately 30 and 42 inches facilitate adequate tractor cultivation and harvesting on sandy soils. Rows 36 inches apart are suitable on the organic soils.
5. Cultivate to control weeds as required. At last cultivation, sandy soil should be removed from wide-row middles and used to hill-up rows as much as possible.
6. Harvest with forage harvester or grain combine, depending on crop stage and usage. Use the forage harvester for fresh-cut feed and silage. A grain combine with header attachment is adaptable for use when only grain is desired. Any grain harvested for storage should be artificially dried to a moisture content of 15 percent.
7. Apply recommended fertilizers at time of cultivation for the growth of ratoon crops of sorghum. Normally this cultivation should suffice for 1 ratoon crop. Follow fertilization and successive ratoon cropping procedure as long as sorghum stands allow profitable culture. In sandy soil 1,000 pounds per acre of an 8-8-8 or 8-12-12 fertilizer gives best results. On organic soils sorghum following winter vegetables usually does not need additional fertilizer. On virgin peat soils apply 500 pounds per acre of an 0-8-24 containing 3.0, 2.0, 1.2 and 0.7 percent of CuO, MnO, ZnO, and B<sub>2</sub>O<sub>3</sub>, respectively. The CuO may be omitted if 25 pounds of 50-percent copper oxide or 50 pounds of 25-percent copper sulfate has been applied separately. Initial applications of copper to organic soils should be made at least 2 weeks prior to planting the sorghum crop. The mixed fertilizer should be applied broadcast to organic soils. For the best growth of sorghum plants, the organic soil pH value should be reduced to 5.8 to 6.0 by an application of agricultural sulfur.

U. Fla., Fla. Agr. Expt. Sta., Gainesville, Fla.

Franke, H. W., Riggs, J. K., Wolters, F. A., Butler, O. D., Sorenson, J. W., and Magee, A. C. MOIST SORGHUM GRAIN AND ROUGHAGE PRESERVED IN SEALED STORAGE FOR GROWING AND FATTENING BEEF CATTLE. Tex. Agr. Expt. Sta. Prog. Rpt. 2160, 7 pp. 1960.

Sorghum grain can be harvested successfully at a moisture level of 31 percent with standard self-propelled combines by slowing the ground speed and maintaining the cylinder speed at that used for threshing small grains.

Moist sorghum grain (31 percent) and Sudan forage of 50 percent moisture content (haylage) can be stored successfully without spoilage in an air-tight, glass-lined silo.

Sorghum grain harvested at 31-percent moisture yielded 4,964 lbs. per acre. Grain from the same fields, but harvested at 10-percent moisture, yielded 4,228 lbs. Sudangrass cut between the heading and early-bloom stages and placed in the silo at 50-percent moisture content yielded 6,140 lbs. per acre. When cured as hay, the yield was 2,219 lbs. When fed to steer calves during a 252-day growing and fattening period, the production of 1 acre of Sudan as haylage fed 1.25 steers, while the production as hay fed only 0.8 steer. An acre of sorghum harvested as moist grain fed 1.9 steers, but when harvested as dry grain fed only 1.5 steers.

During a 112-day growing period, in which weaned steer calves were fed a full feed of roughage and 4 lbs. of moist or dry sorghum grain with protein supplement, the gains significantly favored the use of Sudan hay over haylage. The steers fed dry sorghum grain required about 10 percent more feed on a dry basis to produce a 100-lb. gain than similar steers fed moist grain. Daily gains

were about the same for the two types of grain, but daily feed intake was 0.7 lb. less on a dry basis for the cattle fed moist grain.

During a 140-day fattening period, the average daily gains were slightly higher for the groups fed Sudan haylage. The average daily gains were about the same for both types of grain. The groups fed dry sorghum grain required 17.6 percent more feed (dry basis) to produce a 100-lb. gain than the groups fed moist grain.

During the combined growing and fattening periods, totaling 252 days, moist sorghum grain produced gains equal to dry sorghum grain, and high moisture hay produced gains equal to regular hay. On a dry basis, the groups fed dry sorghum grain required about 13 percent more feed to produce a 100-lb. gain.

Carcass grades significantly favored the groups fed Sudan hay. The Sudan hay groups produced 15 Choice and 7 Good grade carcasses while the haylage groups produced 5 Choice and 15 Good carcasses. Carcass grades were slightly higher for cattle fed dry grain than for those fed moist grain.

Selling prices for the steers were determined for feedlot weights based on carcass grades and prices. Prices per hundredweight were as follows: Sudan hay-dry grain, \$26.11; Sudan Hay-moist grain, \$25.00; Sudan haylage-dry grain, \$24.81; and Sudan haylage-moist grain, \$25.48.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Duke, G. B. MECHANIZED HARVESTING OF VIRGINIA PEANUT CROP.  
Trans. ASAE. 3(2): 138-139. 1960.

Over 90 percent of Virginia's peanut crop is dug with one-row diggers, stacked on poles, and picked with stationary pickers. In adapting the windrow method of harvesting to Virginia conditions, improvements were needed and made on peanut diggers, shakers, and combines. The windrow method of harvesting peanuts is similar to methods previously adapted in other areas. The crop is dug with two-row diggers, turned and fluffed again with a shaker-windrower 2 to 3 days after digging, and harvested with a peanut combine as few as 6 to 8 days after digging.

Recent model peanut combines showed improvements in capacity and picking efficiency over previously tested models. Handling peanuts in bulk requires less labor and cost and is preferred to handling in bags. Recovery yields from combining compare favorably with recovery yields obtained from stacking.

Freshly dug Virginia peanuts normally contain over 50-percent moisture and when combined 6 to 8 days after digging the moisture content has been reduced to 20 to 30 percent. All windrow-harvested peanuts must be artificially cured and dried before storing or marketing.

Only 6 to 8 growers in Virginia used peanut combines in 1957; at least 16 growers used combines in 1958. Factors limiting the acceptance of the windrow method of harvesting peanuts in Virginia are the combined high capital outlay required for purchase of diggers, shakers, combines, driers, drying bins or wagons, wiring, fuel, electricity, and moisture tester. Frequent rainy seasons during harvest occasionally cause a delay in picking resulting in losses due to shattering, and discoloration and weather damage of shells and kernels.

AERD, ARS, USDA, Holland, Va.

Loftsgard, L. D., and Miller, W. G. CONTRACTS AND ALLOTMENTS IN  
SUGAR BEET PRODUCTION: RED RIVER VALLEY, NORTH DAKOTA.  
N. Dak. Agr. Expt. Sta. B. 434 (Tech.), 40 pp. 1961.

An analysis of grower-processor contracts and acreage allotments for beet production in the Red River Valley of North Dakota is reported. The analysis is based on data collected in 1959 from samples of 75 beet growers and 79 non-growers who operate farms in this area.

The central hypothesis that directed the study was that contracting for beet production and allotting beet acreages have significant interrelationships with farming conditions in the study area. Attention was directed more specifically to analyzing the farm-tenure implications and effects of the contracts involved. The major findings are summarized as follows:

1. The comparatively low net returns from other crops in the Red River Valley within recent years have strengthened the competitive position of sugar beets as a cash crop. The net income per acre from beets, as reported for 1959, was nearly three times as high as that from other crops combined, excluding potatoes.
2. With the 1959 cost-price relationships and farm resources available, the beet acreage desired per farm was 73 percent greater than the actual acreage.
3. In terms of the distribution of beet production among tenure groups, the analysis indicates no particular group is in a more favorable position. Full tenants and part owners have larger beet acreages on the average than owner operators.
4. The total assets controlled per farm were \$186,476 for beet growers as compared with \$145,580 for nongrowers.
5. The net worth per operator for beet growers was 45 percent higher than that for nongrowers. Growers also had a higher ownership interest in the farm assets they used. In addition to credit facilities furnished by the beet company to beet growers, 68 percent of the growers indicated that having a beet contract placed them in a better position to obtain credit from any source.
6. On the average, land values per acre for beet-producing farms are only 5.3 percent higher than values for the other farms. If beet acreage were transferable to a land buyer, the value of the land probably would be increased by an average of \$35 per acre for a "quarter section of land with a 40-acre beet allotment." Or, in terms of actual beet acreage, a beet allotment would be worth \$140 per acre.
7. Leasing conditions are particularly affected under beet production to the extent that: (1) Cash rent per acre for beets is higher on the average than cash rent paid for other crops; (2) the continuation of some leases is contingent upon having contracts to produce beets; (3) some leases require acceptance of the sugar company's recommendations on farming practices for beets; and (4) some landlords participate more actively in the management of their farms' business because of beet production.
8. With respect to decisions on beet growing, farmers generally have confidence in the techniques and practices recommended by the fieldmen of the sugar company with whom they have contracts.

N. Dak. Agr. Expt. Sta., N. Dak. State U. Agr. and Applied Sci., Fargo, N. Dak.

Smith, T. J., Camper, H. M., Carter, M. T., Jones, G. D., and Alexander, M. W. SOYBEAN PERFORMANCE IN VIRGINIA AS AFFECTED BY VARIETY AND PLANTING DATE. Va. Agr. Expt. Sta. B. 526, 30 pp. 1960.

Six soybean varieties (Clark, Perry, Hood, Lee, Dorman, and S-100) ranging in maturity from very early to late were planted at 2-week intervals from May 5 to July 5 in Virginia. All seedings were made in 3-foot rows at the rate of 10 germinable seeds per foot of row.

Excellent plant stands were obtained in most instances on the sandy Coastal Plain soils. Cold, wet weather following early seeding and dry weather during late seedings resulted in poor stands in some instances. Very poor stands were produced on the Davidson cl soil at Orange for the late (June and July) seedings



in 3 of the 4 years. Soybeans emerged more rapidly on the sandy Coastal Plain soils than on the clay loam soil in the Piedmont. At all locations, seedlings emerged much slower when planted on May 5 than for later seeding.

The rate of plant growth following emergence varied considerably when seedlings were made at different dates and locations. All varieties when seeded on May 20 produced plants that grew faster and covered the areas between rows at approximately the same date as plants from seedlings made 2 weeks earlier. Plants from late June and early July seedlings were smaller and less effective in shading the ground between the rows than plants from earlier seedlings. Late varieties were more effective in covering (shading) the ground between the rows than early varieties, especially when planted at the later dates.

The Dorman variety covered the ground earlier than all other varieties. The Hood variety generally covered the space between the rows more slowly than all other varieties.

Plant heights of the different varieties varied considerably from year to year at the different locations. The general trend was for midseason plantings to produce taller plants than for either the earlier or later seeding dates.

The lower pods were set closer to the ground for late June and early July seedlings than for earlier seedlings, but late varieties were less affected by date of planting than early varieties. Early varieties, except S-100, produced pods closer to the ground than late varieties when planted at the same date and location.

Lodging varied considerably depending upon year, planting date, variety, and location. There was no clear-cut effect on lodging due to date of planting, but early varieties lodged less than late-maturing varieties for late dates of planting in most years.

A delay in planting normally produced a delay in maturity but not to the same extent. Late-maturing varieties were delayed less in maturity by a delay in planting than early varieties.

In general, maximum yields were obtained from the May 20 or June 5 seeding dates with progressively lower yields from later planting dates. There was little yield advantage for planting as early as May 5, and considerable disadvantage in some years. Seedlings on June 20 and July 5 produced on the average much lower yields than that obtained from earlier plantings.

Late varieties were superior in average yield performance at Warsaw and Holland, but there was little difference between average yields of early and late varieties at Orange and Petersburg. Late planting also favored full season varieties at Warsaw and Holland with little differences in yield due to maturity for later plantings at Orange and Petersburg.

The later maturing varieties produced on the average seed with better quality than early varieties. Date of seeding had little effect upon seed quality of full season varieties. Early-maturing varieties produced poorer seed quality for early than for late seeding in most years. Seed of early-maturing varieties deteriorated much more rapidly when left in the field after maturity than seed of late-maturing varieties.

Protein content of soybean seeds from the different varieties showed no consistent effect due to date of planting. Oil content averaged slightly less from the July 5 seeding than from earlier planting.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

Willman J. P., Johnson, G. R., and Brannon, W. F. CULL BEANS FOR FATTENING LAMBS. Cornell U. Agr. Expt. Sta. B. 959, 16 pp. 1961.

In a series of trials 1946-54, cull dry beans were evaluated as a concentrate for fattening white-faced western feeder lambs.

Cull beans, when cooked and supplemented with 10-percent linseed meal, may be very nearly equal to shelled corn, pound for pound, in fattening lambs.

The experiments indicate that raw beans are considerably less valuable. When compared with corn, 50 percent more raw beans may be required to produce an equal quantity of lamb gain. When raw beans were fed, scouring, "off-feed", poor feed consumption, and poor gains were common ailments and problems encountered.

The addition of approximately 10 percent linseed meal to the ration consistently improved the gains of lambs when fed either raw or cooked beans. Soybean meal was about equal to linseed meal as a supplement. Brewers' dried yeast, when substituted for linseed meal on a similar total protein basis, appeared to produce a slightly slower gain and more feed was required. No advantages were noted in these trials when copper and cobalt were added to the rations.

Cornell U. Agr. Expt. Sta., N. Y. State Agr. Col., Ithaca, N. Y.

Sill, W. H., Jr., Fellows, H., and Heyne, E. G. REACTIONS OF WINTER WHEATS TO SOIL-BORNE WHEAT MOSAIC VIRUS IN KANSAS. Kans. Agr. Expt. Sta. Tech. B. 112, 7 pp. 1960.

Since 1950, the reactions of 254 varieties, selections, and crosses of winter wheat to mosaic virus have been tested. Fifty-six named and unnamed varieties are reported as resistant to soil-borne wheat mosaic virus in Kansas. Of these, only Concho, Comanche, and Ottawa are now recommended in the State. Ample evidence is presented to prove that this virus causes widespread economically important losses even in years when symptoms on susceptible varieties are diffuse or absent. Breeding work is being continued in Kansas to develop more agronomically satisfactory, high-milling quality winter wheat varieties high resistant to mosaic.

This paper lists the reactions of many winter wheat varieties, selections, and crosses to soil-borne wheat mosaic virus in Kansas and discusses expected yield reductions from this disease.

CRD, ARS, USDA, and Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Dodds, M. E. THE EFFECT OF SWATHING AT DIFFERENT STAGES OF MATURITY ON THE BUSHEL WEIGHT AND YIELD OF OATS. Canad. J. Plant Sci. 41: 401-406. 1961.

Swathing tests were conducted over a 4-year period to determine the earliest stage of maturity at which oats could be cut without loss of bushel weight or yield.

Cutting started when the kernel moisture content of the standing crop approximated 50 percent and continued daily until the moisture content reached 14 percent. The weight per measured bushel, 1000-kernel weight, and yield in bushels per acre were determined at the time the swath was picked up and threshed with the combine.

An analysis of variance of the data indicated that oats may be swathed at a stage of maturity defined by a kernel moisture content of 35 percent without affecting bushel weight or yield. Kernel moisture at swathing was significantly, negatively correlated with the bushel weight, 1000-kernel weight, and yield for the full range of the test, but this relationship became a lower order as maturity advanced and was not correlated at a moisture level below 35 percent.

Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

Baird, D. M. EFFICIENCY OF VARIOUS SILAGE COVER MATERIALS FOR REDUCING TOP SPOILAGE IN TRENCH SILOS. Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 106, 15 pp. 1960.

Six different seals or covers for trench silos were checked during 3 years to compare their effectiveness in preventing top spoilage of the silage. From these tests the following conclusions appear justified: (1) Plastic alone was not a satisfactory cover due to ease of puncture with resultant high silage losses under the punctures; (2) plastic covers with either dirt or damp sawdust almost eliminated top spoilage; (3) plastic was more expensive than felt building paper but was easier to apply and was a more effective cover when a layer of dirt or sawdust was applied over the plastic; (4) felt paper covered with sawdust reduced the top spoilage over 40 percent compared with a covering of dirt over the felt; (5) felt paper with a cover of sawdust reduced the top spoilage about 56 percent when compared with sawdust alone; (6) sawdust is easier than dirt to apply and remove and was more effective in preventing top spoilage when used to cover either plastic or felt paper; and (7) thoroughness of packing is essential to prevent an excessive rise in silage temperature.

Ga. Agr. Expt. Sta., U. Ga., Col. Agr., Athens, Ga.

Nieto H., J., and Staniforth, D. W. CORN-FOXTAIL COMPETITION UNDER VARIOUS PRODUCTION CONDITIONS. Agron. J. 53: 1-5. 1961.

Corn-foxtail competition was investigated over a 2-year period. Infestations of yellow and green foxtail were grown with corn to maturity or removed early in July. Additional variables included 3 levels of soil fertility and 4 levels of corn plant populations. Supplemental irrigation water was available for part of the experiments. Dry-matter yields of aboveground plant parts of foxtail and yields of mature corn were obtained.

Nitrogen fertilizer applications minimized the effects of foxtail competition on corn, as measured by reductions in corn yields. For both years, corn yield reductions resulting from mature foxtail infestations averaged approximately 20, 14, and 10 bushels per acre, respectively, with applications of 0, 70, and 140 pounds per acre of elemental nitrogen and an over-all application of 300 pounds per acre of 0-20-20 fertilizer. The responses of all three varied widely with corn plant population levels.

Growth and yield of foxtail infestations were severely depressed with higher levels of corn populations. Values for the bushels of corn yield reduction per hundredweight foxtail infestation varied with nitrogen level and decreased as foxtail infestation increased in those combinations of nitrogen fertilizer and corn populations where competition was most severe. When corn-foxtail competition was less severe, the values for bushels reduction per hundredweight foxtail were uniform across a range of foxtail infestations.

J. Paper J-3813, Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Metzer, R., and Rayall, W. C., Jr. FIELD TESTS OF THREE CHEMICALS AS BIRD REPELLENTS ON MATURE GRAIN SORGHUM. Tex. Agr. Expt. Sta. MP 524, 6 pp. 1961.

A cooperative study to evaluate three chemicals for repelling birds on mature grain sorghum was initiated in the summer of 1959 at College Station. The three chemicals used were Arasan 42-S, B-187, and B-188; the latter two are experimental products.

Notes on the threshing percentage of sorghum and daily observations of bird feeding and mortality from each treatment were taken to give the necessary data for evaluating the three bird repellents.



The most effective chemical for repelling birds was Arasan 42-S and the least effective repellent was B-188. Sorghum treated with 1 to 5 percent 42-S had the highest average threshing percentage and little or no observed feeding. Sorghum treated with 5 to 11 percent active B-188 had only slightly higher average threshing percentage than untreated sorghum. B-187 was superior to B-188 in repelling birds, but only the sorghum treated with 11 percent active B-187 had a threshing percentage as high as sorghum treated with Arasan 42-S. The effectiveness of each chemical in repelling birds varied according to the severity of the particular test in which the repellent occurred. In tests with untreated sorghum, the least effective repellent, B-188, provided some protection from birds, but failed to repel birds in tests with a more effective repellent such as Arasan 42-S.

A reduction in seed viability occurred in sorghum treated with 5.5 percent and 11 percent active B-187. Some browning and bleaching of sorghum leaves also were observed in certain plots treated with B-187 and B-188. Neither chemical as formulated in this study merits continued field testing on grain sorghum in the presence of heavy bird feeding pressure.

Arasan 42-S is a "zero tolerance" product that is limited to production of sorghum for seed where none of the product enters the feed market.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Hieronymus, T. A. WHEN TO SELL CORN, SOYBEANS, OATS, WHEAT. Ill. Ext. Serv. Agr. and Home Econ. C. 833, 44 pp. 1961.

Choosing the time to market grain is a difficult and important task. Here is the key question in deciding when to sell corn, soybeans, wheat, and oats: Will the price rise enough from harvest to the time of selling to more than cover the costs of holding grain? This circular attempts to help farmers answer that question by describing the post-World War II patterns of grain prices and costs of storing the grains.

U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Ross, J. S., and Yeager, J. H. COSTS AND RETURNS OF PRODUCING RUNNER PEANUTS IN SOUTHEASTERN ALABAMA. Ala. Agr. Expt. Sta. B. 330, 32 pp. 1960.

Input and cost data applicable to producing runner peanuts on 79 farms in four southeastern Alabama counties in 1958 were studied.

Peanut fields ranged from 1/2 to 55 acres in size. The average was 10 acres. On mechanized or partially mechanized farms, fields in which combines or pull-type pickers were used averaged 12.9 acres compared with 7.6 acres for fields in which stationary pickers were used.

Acreage of peanuts harvested in 1958 ranged from 2.7 to 233 per farm. The average was 33.4 acres. Average yields for 1955 through 1957 ranged from 700 to 2,200 pounds of peanuts per acre with an overall average of 1,280 pounds. Although 61 out of 79 farmers reported saving hay, this was done on only 54 percent of the peanut acreage.

Forty-six percent of the farmers reported some peanuts planted for hogging purposes. The average was 8.2 acres per farm reporting. Hogs were used to glean fields after harvest on about half of the harvested acreage.

Peanut enterprises on 69 mechanized or partially mechanized farms were classified as small (less than 10 acres), medium (10 through 29.9 acres), and large (30 acres or more). Total man-hours per acre averaged 57 for small, 44 for medium, and 35 for large enterprises. Farmers with small enterprises averaged 29 man-hours and those with large enterprises 13 man-hours per acre in harvesting. Seventy-two percent of the large enterprise farmers used combines or pull-type pickers.

Thirty-two of the 69 farmers used combines or pull-type pickers and 37 used stationary pickers in 1958. When combines or pull-type were used, total man-hours per acre averaged 30 compared with 56 when stationary pickers were used. Man-hours per acre used in harvest operations were reduced from 29 to 10, or 66 percent, by use of combines or pull-type pickers.

Ten farmers who used workstock primarily in producing peanuts averaged 93 man-hours per acre total time.

The total average cost per acre of producing peanuts was \$90, \$80, and \$68, respectively, on small, medium, and large enterprise farms. Farmers with large enterprises used more fertilizer and seed per acre than did the other two groups. They also spent more for insect and disease control. This offset part of the lower labor costs of the large enterprise group. Farmers who used combines or pull-type pickers produced peanuts for \$67 per acre compared with \$87 per acre for those using stationary pickers.

Average yields of peanuts per acre were not greatly different according to size of enterprise groups or methods of harvest. Farmers in the small size group averaged \$49 net return per acre, whereas those in the large enterprise group averaged \$77 per acre. All costs, cash and non-cash, were included in arriving at net returns. Farmers who used stationary pickers had an average net return per acre of \$52 compared with \$75 for those using combines or pull-type pickers. There was a negative average net return for the 10 workstock farms when family labor was counted as an expense.

In harvest operations, land preparation, planting, fertilizing, and cultivating somewhat lower man-hours per acre prevailed as size of enterprise increased.

Agr. Expt. Sta., Auburn, U., Auburn, Ala.

Justus, F. E., Jr. COTTON PRODUCTION COSTS AND RETURNS. Mo. Agr. Expt. Sta. B. 758, 20 pp. 1961.

Detailed production records kept by 42 farmers on the 1959 cotton crop provided the data used in this report. Purpose of this project was to determine the costs and returns of producing cotton by size of cotton enterprise (acres), and to study the influence of various factors such as level of mechanization, lint yield per acre, price received for lint, and level of fertilizer use on net income. Among the more important results revealed were:

1. It cost farmers \$149.05 per acre to produce cotton in 1959. The average cost amounted to \$22.03 per 100 pounds of lint.
2. There was considerable variation in costs. Total costs on individual farms varied from \$15.44 to \$28.68 per 100 pounds of lint.
3. Labor and machinery costs amounted to nearly 58 percent of the total cost of producing cotton.
4. 1959 was an excellent year for cotton production in Missouri. Average lint yield on the study farms was 680 pounds per acre. As the farmers received an average of \$31.36 per cwt. of lint, the lint receipts amounted to \$202.14 per acre. Total receipts from lint and cotton seed averaged \$234.49 per acre.
5. Net returns to management averaged \$85.44 per acre. For every \$100 these farmers spent for the use of land, labor, and capital they received an average of \$158.71 in returns.
6. Tremendous variation occurred in the net returns per acre on individual farms with the range being from \$30.18 to \$169.28.
7. Total costs per acre and per 100 pounds of lint averaged higher on farms having small cotton acreages than on those having larger acreages. There was far more variability in the total costs on the smaller acreages than on the larger acreages. Both the farmer with the lowest cost per acre in the entire study and the farmer with the highest cost produced less than 20 acres of cotton.

8. Returns to management averaged somewhat lower on the farms with the small acreages. The same thing was true as with costs; the farmer with the highest as well as the farmer with the lowest net returns per acre produced less than 20 acres of cotton.
9. The study revealed that the small farmer must be careful in labor and machinery costs and he must be particularly careful to held down fixed machine ownership costs.
10. Lint yields had a tremendous influence on net returns per acre. An increase of lint yields from 520 to 831 pounds per acre almost doubled the net income per acre.
11. The data revealed that farmers should strive for high-quality cotton and carefully analyze their marketing alternatives.
12. One of the major factors in obtaining high cotton yield is the proper use of commercial fertilizer.
13. A comparison was made of the costs and returns of producing cotton by soil textural properties. Lint yields were highest on the "heavy" soils but because of the higher costs on these soils the farmers having sandy loam soils received the highest net returns per acre. Farmers on the light sandy soils had the lowest lint yields, lowest costs, and the lowest net returns per acre.
14. Generally speaking, the more labor involved in the harvesting operation the higher were the total harvesting costs per acre and per 100 pounds of lint.

U. Mo., Agr. Expt. Sta., Columbia, Mo.

Brooks, O. L., and Perry, C. E. COTTON PRODUCTION AT THE SOUTHEAST GEORGIA BRANCH EXPERIMENT STATION. Ga. Agr. Expt. Sta. C. N. S. 22, 22 pp. 1961.

An attempt was made to combine the best methods and practices in a cotton production program and to evaluate the results of the methods and practices in terms of costs and returns. These methods and practices are as follows: (1) The use of disk coulters on bottom plows has aided in control of early crabgrass and sand spurs. (2) Planting to a stand has eliminated the expensive job of hand chopping. This practice has also reduced seeding rates from as high as 3 bushels per acre to as low as 12 to 15 pounds of acid delinted seed. This reduction in seed rate alone is saving enough to pay for pre-emerge chemical weed control. (3) A 14" band of pre-emerge chemical weed control has been used on all cotton for 6 years. Grass control has been adequate every year when there was enough rainfall to activate the chemical. (4) The broadcast application of mixed fertilizer by spreader truck has eliminated the possibility of "fertilizer burn" to cotton seedlings. (5) All nitrogen used has been applied before planting as anhydrous ammonia. (6) Breeder's seed have been used each year. (7) A carefully planned and closely followed insecticide program has been one of the greatest contributing factors to the net returns. And (8) defoliating and control of late-season grass has been necessary for successful harvest with mechanical pickers. Grass has been controlled to the extent that only 2 percent of cotton has been down graded due to grass content.

In addition to increasing yields per acre, cost per pound of lint was reduced by fertilization in accordance to soil needs, and by the reduction in labor required to fertilize, plant, control weeds, and, particularly, to harvest.

The economic analyses indicate several methods of reducing cost by using improved practices as compared to not using these practices. However, the cost of various machines employed requires that acreage allotments be large enough to provide each machine a fairly complete work load, if economic returns are to be made.



Table--Cost and Returns per Acre, Three-Year Average Cotton Yield, 1958-60,  
Southeast Georgia Branch Experiment Station, All Improved Practices

Item	Description	Amount	Unit	Price	Value
				dollars	dollars
Receipts					
Lint		684	lbs.	0.3189	318.13
Seed		1,183	lbs.	0.0183	21.65
Total					239.78
Expenses					
Seed	Acid delinted breeder's seed	15	lbs.	0.1275	1.91
Fertilizer	0-10-20 bulk spread	5	cwt.	2.01	10.05
Anhydrous Ammonia	96" applicator	75	lbs.(N)	0.097	7.28
Lime	1 ton every 5 yrs.	.2	ton	7.50	1.50
Pre-emerge	Chloro IPC	.5	gal.	8.00	4.00
Hired labor	Hoeing	11.2	hr.	.30	3.36
Insecticide	4-2 Toxephene, DDT	6.77	gal.	2.60	17.60
Insecticide	Methyl Parathion	1	acre	2.78	2.78
Defoliant	Folex	1	acre	3.20	3.20
Hail Insurance		1	acre	4.69	4.69
Tractor, large		4.20	hr.	1.498	6.29
Cotton sprayer	8-row	2.67	hr.	1.31	3.50
Picker	1-row	1.4	hr.	6.946	9.72
Other machinery		---	---	---	1.22
Hauling		1.368	bale	.40	.55
Ginning		1.368	bale	13.15	17.98
Warehouse cost		1.368	bale	1.479	2.02
Interest on operating capital 6%, 9 mo.		56.37	---	---	2.54
Labor		2.39	hrs.	.75	1.79
		6.61	hrs.	1.06	7.01
Total Expense					108.99
Net returns to land and management					130.79

Other Tables were summarized as follows:

Net returns to land and management where all improved practices were used except 4 row equipment ----- \$124.80

Net returns to land and management where all improved practices were used except bulk spread fertilizer----- \$129.46

Net returns to land and management where all improved practices were used except spraying ----- \$130.96

Net returns to land and management where all improved practices were used except mechanical harvest ----- \$89.73

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Net farm income remains low for many families on flue-cured tobacco farms in Southside Virginia. The low income problem continues in contrast to high levels of employment and income in the non-farm sectors of Virginia's economy.

The optimum combination of enterprises for maximizing farm net revenue from fixed resources on a typical flue-cured tobacco farm under several sets of conditions was studied.

The typical farm was chosen by analyzing survey schedules of farm resources in Southside Virginia. The farm selected was a modal situation with 60 acres of open land and 3 acres of flue-cured tobacco allotment, but no major buildings suitable for commercial livestock. Investment capital in the amount of \$7,500 was assumed to be at the operator's disposal. Unpaid labor was assumed to be that of the operator plus other family labor.

Enterprise budgets were prepared for each major enterprise believed to have economic possibilities in the area. The level of technology and price data used were both projected to the year 1975. Linear programming techniques, including the use of transfer procedures, were used to determine profit maximizing enterprise combinations for several sets of assumed conditions.

It was concluded that:

1. Farmers on typical flue-cured tobacco farms of 60 acres of open land in Southside Virginia do have an opportunity to increase substantially net farm income. Flue-cured tobacco allotments should continue to be planted in full but additional enterprises will have to be added.
2. Enterprises to add to a farm of this size are those requiring limited amounts of land with high returns to capital investment. Market hogs and layers constitute the most profitable additions to present enterprises in developing the optimum plan.
3. Aromatic tobacco is not a profitable substitute for flue-cured tobacco unless the size of the flue-cured allotment is reduced. A small amount of aromatic tobacco can be profitably grown along with the full flue-cured allotment.
4. Additional flue-cured tobacco allotment has a high value in an optimum program for a farm of this size. The purchase of additional allotment may compete favorably with the investment of capital in a different enterprise.
5. The amount of investment capital available has an important effect on the optimum combination of enterprises and net farm revenue attainable on the typical flue-cured tobacco farm. Farmers who have the resources assumed could make profitable use of more capital than most of them presently use. The acquisition of such additional capital will depend upon the willingness of credit agencies to lend the money and upon the willingness of farmers to assume risks associated with an increase in their debt load.

Va. Agr. Expt. Sta., Va. Polytech. Inst., Blacksburg, Va.

### Vegetable Crops

Jones, M. B. PERFORMANCE OF HEAD LETTUCE VARIETIES PLANTED ON DIFFERENT DATES. N. Mex. Agr. Expt. Sta. B. 452, 13 pp. 1961.

Late July, early August, and mid-August were tested as planting dates for several varieties of head lettuce for the fall crop in southern New Mexico. Planting as early as July 25 caused a larger percentage of the plants of all varieties to

bolt or fail to produce marketable heads. Some bolting and other hot-weather defects were also encountered in part of the August 5 plantings. Delay of planting until August 15 or later may subject the crop to hard freezes near maturity. August 10 appears to be an optimum planting date for the fall crop in the area.

November, December, January, and February plantings were made with several varieties for the spring crop. Planting as early as November 20 may result in the plants failing to make good head size in some years. As planting date is delayed past December 20, the hazard of tipburn increases. December 10 appears to be an optimum time for seeding spring lettuce in southern New Mexico.

Of the strains and varieties tested 19 are reported. Great Lakes Premier was the most consistently high-yielding variety, but lighter green color and low tipburn resistance greatly limit its possibilities. Great Lakes 659 or 659-G and Primavera were consistently low in percentage tipburn and bolting, and were outstanding. These strains may give small head size under certain conditions. Great Lakes 66, A-36, 407-P, and R-200 are strains that make good head size when temperatures are a little below optimum, and can be used where the crop will be maturing during cool weather.

A variety and planting date guide is presented.

N. Mex. State U., Agr. Expt. Sta., University Park, N. Mex.

Shadbolt, C. A., and McCoy, O. D. TEMPERATURE AND PLANT RESPONSES TO PAPER AND PLASTIC PROTECTORS ON CANTALOUPE. *Hilgardia* 30(9): 247-266. 1960.

The value of standard glassine caps when used alone and in conjunction with brush was studied. A treatment using parchment paper as continuous row covers was also included. These were approximately 10 inches wide at the base, and about 12 inches high. The covers were applied over the seeded row and the field was irrigated on December 16, 1955. Four replications and a 65-foot harvest row were used. The results were summarized as follows:

1. Brush used in addition to standard glassine caps provided greater early growth and greater yields than the caps alone. Both day and night temperatures were higher than with nonbrushed treatments, and up to 10° F. potential frost protection was obtained. The use of brush in conjunction with plastic continuous and individual covers showed similar advantages.
2. Plastic films, when used as individual plant covers, showed no advantage over paper materials. Minimum temperatures under the plastic films were usually slightly lower than under comparable glassine covers.
3. Continuous plastic covers were usually superior to individual covers. The physical properties of paper made this material impractical for use as continuous covers in the area in which the testing was done. Continuous plastic covers increased emergence and early plant growth, and provided earlier fruit set and greater, earlier yield than individual caps. Minimum temperatures which varied from 4° to 7.5° F. above outside air temperature were recorded under continuous covers compared with 2° to 6° F. under conventional glassine caps.
4. No difference in plant response could be measured under perforated and nonperforated continuous plastic covers. Slightly lower minimum temperatures were measured when the covers were perforated.
5. Wide continuous covers covering a maximum of soil area were found superior to narrow and higher covers.
6. Plants under plastic covers were found to have a higher moisture and nitrate-nitrogen content than plants under paper covers.
7. After emergence of the plants, ventilation of the plastic covers to reduce humidity and moisture condensation was found to be essential.

Agr. Publications, Room 207 U. Hall, 2200 U. Ave., Berkeley 4, Calif.



Hand-tilled plots demonstrated the response of potato roots to deep-tillage and deep-placement of fertilizer. A complete shattering of the plowsole hardpan promoted deeper and heavier rooting in the soil layers below the plow layer. Deep fertilization did not produce a significantly higher concentration of roots in the enriched layer, nor did deep fertilization retard deeper rooting. Apparently, density of the subsoil, and not the lack of fertility, was the primary factor causing the reduction in root growth.

In a commercial field, the outcome of compaction depended upon soil texture. Where the texture was fine, approaching a fine sandy loam, root growth was restricted beneath the track of the tractor and sprayer. On the other hand, where the texture was coarser, approaching a loamy sand, the roots were abundantly and finely branched in the compact soil beneath the track. In both cases, but especially in the finer-textured soil, the roots were restricted by the plow pan.

Conn. Agr. Expt. Sta., New Haven, Conn.

Comin, D. INHIBITING SPROUTING OF POTATOES AND ONIONS IN STORAGE IN OHIO. Ohio Agr. Expt. Sta. Res. B. 874, 27 pp. 1961.

In any discussion of maleic hydrazide (MH) as a sprout inhibitor for use with potatoes and onions, it should be realized that the effectiveness of this chemical is entirely dependent upon how much of the chemical reaches the meristematic growing points, in this case the "eyes" of the tubers and the stem plate of the onion bulbs. The factors affecting this transfer of maleic hydrazide is discussed in some detail.

There are strong interactions between the factors of dosage, time of application of the MH relative to the stage of plant growth, time of application relative to the relative humidity of the air surrounding the plants, and undoubtedly many others. This means that the results obtained by growers in the use of this chemical will depend largely on how closely they adhere to the recommended dosage and time of spraying relative to the recommended stage of growth, etc.

The data support the view that 4 to 6 pounds per acre of MH-40 or 4-1/2 to 7 pints of MH-30 would most often give very good control of sprouting with both potatoes and onions when properly applied. The exact quantity of maleic hydrazide used may best be decided on the basis of degree of sprout inhibition desired and the consideration of economy. The recommendations made from this work are:

1. The quantity of maleic hydrazide used should be the same for both potatoes and onions.
2. MH-30 is the only material commercially available at present and is satisfactory.
3. It seems advisable to use 150 gallons of spray mixture per acre in order to sufficiently wet the foliage to run off.
4. The concentration of maleic hydrazide resulting in good sprout inhibition is approximately 1,750 p.p.m. This requires approximately 4 pints per 150 gallons of water, or 6 pints of MH-30 per acre.
5. The time of application of the maleic hydrazide may be critical and is surely an important factor in the results obtained. Onions should be sprayed 1 to 2 weeks before harvest and potatoes should be sprayed at blossom fall or soon thereafter.
6. No applications of MH salts should be made when rain is forecast within 24 hours of an intended spray date. High gallonage with high humidity

causes excessive runoff and less absorption of active material from foliage surfaces.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Elmer, O. H. SWEETPOTATOES AND THEIR DISEASES. Kans. Agr. Expt. Sta. B. 426, 49 pp. 1960.

The sweetpotato is one of Kansas' most important vegetables, both as a high income crop for the grower and as a highly desirable food. Many acres of light sandy loam soils suitable for sweetpotato production are found in the Kansas and Arkansas river valleys and in many other smaller areas in southern and eastern Kansas.

Sweetpotatoes have been produced commercially in Kansas since about 1890. Much of the land best suited for them has become contaminated with sweetpotato disease-producing fungi that persist in the soil many years. While climate and soils remain suitable, diseases and other pests are in many places now the chief limiting factors for producing this crop.

Effective methods for controlling diseases and other pests are, as a rule, closely correlated with culture, harvesting, and storage. This bulletin describes various diseases and pests that attack sweetpotatoes and describes measures that have proved effective for controlling them.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Bergman, E. L. CELERY BLACKHEART AND ITS CONTROL IN PENNSYLVANIA. Pa. Agr. Expt. Sta. Prog. Rpt. 215, 5 pp. 1961.

A field survey which included soil and plant analyses, a field spray test, and a greenhouse nutrient solution experiment were undertaken to find the cause and devise a control for blackheart of celery in Pennsylvania. From results these conclusions may be drawn:

1. Blackheart apparently appears in Pennsylvania when calcium becomes insufficiently available to the plants. This may be because of calcium deficiency, because of extremely high levels of potassium in the soil, or because of both.
2. Blackheart symptoms are accentuated by drought. Weekly irrigations of at least 1 inch of water seemed to aid in its control.
3. Soil in which celery is to be planted should be analyzed for potassium, calcium, and magnesium before application of any fertilizer.
4. To be safe, available potassium in the soil should not be higher than 375 pounds per acre depending on available calcium.
5. No evidence was uncovered that tarnished plant bug causes blackheart.
6. Boron toxicity symptoms were found little different from blackheart.
7. Applications of boron did not control blackheart. Soil treatments or spray applications should be made only when recommended by specialists or when boron deficiency is definitely established.
8. Caution should be used in selecting plants for seed production. Development of blackheart resistant strains adapted to Pennsylvania conditions are needed.

Pa. State U., Col. Agr., Agr. Expt. Sta., University Park, Pa.

Cravens, M. E.; and Allen, J. P. MARKETING POTATOES IN DEFICIT VS. SURPLUS PRODUCING AREAS: A COMPARISON OF RED RIVER VALLEY AND OHIO. Ohio Agr. Expt. Sta. Res. B. 877, 15 pp. 1961.

The North Central States' potato industry is a heterogenous industry. Potato producers in the several states and areas are affected differently by marketing forces and by legislative acts. Ohio has a production equal to only about 40 pounds

per person in the State while North Dakota has a potato production equal to approximately 1,750 pounds per person residing in that State. Ohio producers market mostly within 100 miles of the producer while North Dakota producers market mostly over 400 miles away. Ohio growers produce in rather small units distributed over the State, while Red River Valley producers are concentrated in the Red River Valley and grow mostly on large acreages. Ohio packer-shippers averaged 11,220 cwt. each compared with 294,394 cwt. each for those in the Valley.

Ohio producers raise mostly white potato varieties while those in the Valley raise mostly red varieties. About one-third of Ohio potatoes are sold for chipping compared with one-tenth of those in the valley.

The Valley has well-developed plants for potato flour and starch production while Ohio has none. The differences found here would seem to preclude the development of any simple national program for handling the potato "problem". No plan yet devised would be of equal help to each production area and much less to each potato grower. In each production area there is a marketing program that will maximize returns to growers. With the differences in marketing considerations that exist, it would seem that the producer in a deficit production area should scrutinize a program suggested by the surplus producing area with considerable care before he lent his support. The reverse is also true. The problems of these two potato-producing areas are so unlike that almost any program that would materially help one area would not help the other area equally.

The continued shifting of potato production, mostly away from the nearby deficit areas to the distant surplus areas, is in itself an indication of the relative advantages of potato production in these two types of production areas. Marketing and support programs often tend to hide the true nature of the problem and to either hinder the needed adjustment or to cause an overadjustment. Improved dissemination of information on production costs and relative returns from potatoes and competing enterprises should speed the necessary and perhaps inevitable adjustments, if markets are allowed to operate and if production is to seek the most efficient area.

The grower in either the declining or the growing area of production must keep informed as to his own strengths and weaknesses, as well as those of his competitor, if he is to continue to succeed in producing and marketing potatoes.

Ohio Agr. Expt. Sta., Wooster, Ohio.

## ECONOMICAL AND SOCIAL ASPECTS OF SOIL AND WATER CONSERVATION

### Costs and Returns

Blosser, R. H. PINPOINTING PRODUCTION COSTS. Crops and Soils 13(6): 14-15. 1961.

Efficient farmers must review their production costs annually to win the ever-pressing battle of the cost-price squeeze.

Today's farmer must always seek out the limiting production factor and weed it from his farming program. A recent Ohio study shows two ways that the farmer can reduce substantially the cost of producing a bushel of grain or a ton of hay.

One proven method is to increase yields per acre by adopting the best crop production practices known. Some of these basic practices include controlling erosion on steep slopes, installing good drainage systems on wet land, planting high yielding varieties at the proper rate and time, applying sufficient lime and



fertilizer, maintaining the organic matter content of the soil, and controlling weeds, insects, and diseases.

The other method of reducing costs is to use tractors and machinery as efficiently as possible. Many farmers will have considerable difficulty reducing farm labor costs to any great extent because they now use only 6.5 hours to produce an acre of corn, 5 hours for an acre of soybeans, and only 4 hours for an acre of small grain.

Figures in the accompanying table show that high crop yields can produce profits that are several times greater than the profit obtainable from average, everyday yields.

Receipts, Expenses and Net Income per Acre in West Central Ohio

Item	Corn		Wheat		Hay	
	60 bu. yield	90 bu. yield	23 bu. yield	30 bu. yield	1.5 ton yield	3.0 ton yield
Receipts <sup>1</sup> -----	\$60.00	\$90.00	\$40.25	\$52.50	\$30.00	\$60.00
Expenses						
Man labor <sup>2</sup> -----	10.35	11.60	4.75	5.25	5.65	10.90
Tractor and machinery-----	15.50	17.25	8.95	9.90	8.05	15.65
Fertilizer, ma- nure and lime--	11.25	17.50	5.75	9.00	.00	1.00 <sup>3</sup>
Seed and spray---	1.75	2.75	4.50	5.00	4.50	6.00
Land-----	15.00	17.00	15.00	17.00	15.00	17.00
Total Expense-----	53.85	66.10	38.95	46.15	33.20	50.55
Net income-----	6.15	23.90	1.30	6.35	-3.20	9.45
Cost per unit-----	0.90	0.73	1.69	1.54	22.13	16.85
	per bushel		per bushel		per ton	

<sup>1</sup> Corn, \$1.00 a bushel; wheat, \$1.75 a bushel; and hay, \$20.00 a ton.

<sup>2</sup> Figured at \$1.50 an hour.

<sup>3</sup> No fertilizer charge was made against the hay crop because it should add enough nitrogen to offset the value of the phosphorus and potash removed by this crop.

The study shows that crop costs can be reduced the following amounts by increasing size of farm from 160 to 640 acres: Corn about 10 cents a bushel; soybeans, 22 cents a bushel; wheat, 15 cents a bushel; and one cutting of hay, \$2.00 a ton. These reductions in cost can be attributed mainly to the use of larger machinery that was utilized more intensively as size of farm increased.

About three-fourths of the farmers on the 160-acre farms used their tractors 350 hours or less per year. A two-plow tractor that is used only 300 hours a year costs about \$1.25 an hour to operate, compared with \$0.90 for 600 hours of necessary use.

A good crop farmer may not have the lowest possible costs on an acre basis because of heavy expenditures for lime and fertilizer. But he should and must have low costs per bushel of grain or ton of hay produced because of high yields.

Ohio Agr. Expt. Sta., Columbus, Ohio.

Fellows, I. F., ed. BUDGETING TOOL OF RESEARCH AND EXTENSION IN AGRICULTURAL ECONOMICS. Storrs Agr. Expt. Sta. B. 357, 45 pp. 1960.

Budgeting has long been an important tool of agricultural economic research and extension. The actual budget process has been treated rather sparingly in the literature and many problems connected with the process have not been discussed extensively.

To explore the technique more thoroughly and to develop uniform definitions and procedures, the subcommittee on Methodology of the Northeast Farm Management Research Committees under the sponsorship of the Farm Foundation planned for a series of papers on the subject.

The following papers are presented:

Fellows, I. F. THE BASIC THEORY AND ASSUMPTIONS UNDERLYING USE OF THE BUDGETING TECHNIQUE. Storrs Agr. Expt. Sta., Storrs, Conn.

Rorholm, N. CONTROLLED EXPERIMENTS AS SOURCES OF INPUT-OUTPUT DATA FOR BUDGETING. U. R. I., Kingston, R. I.

Hess, C. V. FARM SURVEYS AS SOURCES OF INPUT-OUTPUT DATA FOR BUDGETING. ERS, USDA, U. Minn., St. Paul, Minn.

McDaniel, W. E. FARM RECORDS AND ACCOUNTS AS SOURCES OF INPUT-OUTPUT DATA FOR BUDGETING. U. Del., Newark, Del.

Fellows, I. F. PRICE DATA FOR BUDGETING. Storrs Agr. Expt. Sta., Storrs, Conn.

Fellows, I. F. TYPICAL PROBLEMS IN BUDGETING. Storrs Agr. Expt. Sta., Storrs, Conn.

Crossman, B. D. RESEARCH AND EXTENSION USE OF BUDGETING. U. Mass., Amherst, Mass.

Storrs Agr. Expt. Sta., U. Conn., Storrs, Conn.

Back, W. B., and Hurt, V. G. POTENTIAL FOR AGRICULTURAL ADJUSTMENT AND DEVELOPMENT IN THE OUACHITA HIGHLANDS OF OKLAHOMA. Okla. Agr. Expt. Sta. B. B-582, 32 pp. 1961.

The potential for agricultural adjustment and development in the Ouachita Highlands area of Oklahoma was evaluated. A survey of 153 rural households in Latimer County in 1956 revealed that less than 10 percent of the family income was from farming and only about one-third of the rural families had some farm sales. Of the farm sales, about three-fourths was from livestock, principally beef cattle.

Various farm resource situations were programmed to determine farm income earning capacity for beef cattle-feed crop systems of farming. The basic unit in the analysis was a 240-acre farm of which 20 acres was bottomland, 60 acres good upland, 40 acres poor upland, and the remainder woodland and waste. Use of different levels of net farm income as targets indicated the maximum net farm income for the 240-acre farm and for "average" management was slightly less than \$1,000. At this maximum, corn was produced as a cash crop on the bottomland, and bermuda-clover substituted for native pasture on most of the upland. Use of lower income targets resulted in less "intensive" land use. The use of "above average" management in the programs resulted in an increase in

net farm income by about 50 percent over the income with "average" management. Ownership of machinery and equipment, rather than custom hiring of tractor and equipment, resulted in a reduction of net farm incomes for the 240-acre farm.

A 720-acre farm with the same proportions of bottomland, good upland, poor upland and other land as the 240-acre farm provided a net farm income of about \$3,000 for "average" management and for either custom hiring or ownership of machinery and equipment. Nearly \$4,500 in net income could be obtained from this size of farm with "above average" management.

Operator labor required in farming was about one-fourth man-year or less for all the programs with both the 240-acre and 720-acre farms except in the case of the 720-acre farm with ownership of machinery. For that program, about half of the operator's labor was required in farming.

Substantial capital investments would be needed to meet the resource requirements for higher net farm incomes. Several plans for capital accumulation, starting with the "typical" unit of 240 acres were analyzed. With "average" management, there was a very limited potential for development to higher net farm incomes if the resources were to be acquired through borrowing from lending agencies and through savings from current farm earnings. Better results were obtained by use of "above average" management, but the rates of accumulation were low and much risk-taking by the operators would be necessary.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Tompkin, J. R. RESOURCE USE ON FOUR TYPES OF 160-ACRE FARMS IN WEST CENTRAL OHIO, 1956. Ohio Agr. Expt. Sta. Res. B. 885, 19 pp. 1961.

These sample farms show a high correlation between farm type and type-influencing factors. The typical farm shows a high degree of consistency within its organization. In terms of topography and percentage of land in crops, the rougher farms with the greater amounts of permanent pasture have adopted dairy, beef, and sheep enterprises. The more level land, with the higher percentage of cropland, is more generally used for the raising of cash grain or for hog production in which a large quantity of corn is needed.

Rotations used on the various farm types vary directly with the type of feed-consuming livestock on the units. The dairy farmers need, and their farms are more suited to, forage. Thus, they use a 25-percent corn and 50-percent meadow rotation. The cash grain farmers have very little livestock.

These farms show a certain relationship between age of operator and type of farm organization. In general, younger operators seem to start farming with general livestock type organization, evolve to a more specialized dairy or hog operation, and then shift back to general livestock or cash grain farming during the last few years before retirement. This is consistent with amounts of capital, family labor, and risk-bearing ability possessed by operators during the various phases of the life cycle of the farm operation.

The typical 160-acre farm has more livestock housing space than an optimum enterprise combination requires. Twenty percent of the sample units are consolidations of two smaller farms and thus have two sets of buildings. The greatest overinvestment in improvements occurs on the cash grain farms where very little livestock housing is needed. Apparently, these farms were organized for livestock at the time the farmstead was built.

Machinery investment per crop acre is high on these farms because considerably more acreage could be farmed with no appreciable increase in equipment inventory. The normal complement of machinery consists of a complete line of sowing, tillage, and harvesting machines, including two tractors, a combine, and a cornpicker. Only the dairy farmer typically owns a baler. Most of these farmers can justify ownership of major harvesting equipment only on the grounds of timeliness of harvest rather than sufficiency of crop acreage.



When efficiency is measured in terms of the percentage that costs are of gross income (cash receipts plus or minus inventory change), general livestock farms lead with 62.1 percent. Cash grain farms have the high cost percentage of 74.6 percent. Hog and dairy type farms have 67.1 and 68.5 percent, respectively.

The most likely livestock or cash grain farmer has no real estate mortgage and only a few hundred dollars of current indebtedness. Liabilities on the typical dairy or hog farm are not large enough to cause any appreciable amount of capital rationing. Credit is available to most of these farmers at 5 to 7 percent interest rates. Linear programming analysis indicates that the typical operator is stocked somewhat below the optimum rate for the resources available. Thus, in many instances, borrowing additional capital for livestock purchases would probably be profitable.

Only an occasional farmer in the 160-acre sample put land in the soil bank.

Most operators who raised wheat stayed within their wheat acreage allotment, but very few of the sample farmers complied with corn acreage quotas.

Most operators had no government payments in any given year. A few received some wool and lamb payments; a few received payments for pond building, tile, or other soil-improving practices; but the majority of operators received no payments in 1956.

FED, ERS, USDA, and Ohio Agr. Expt. Sta., Wooster, Ohio.

Schmidt, J. R., and Christiansen, R. A. POTENTIAL CROP AND LIVESTOCK PRODUCTION AND NET FARM INCOME ON DOMINANT SOILS IN NORTHWEST WISCONSIN. Wisc. Agr. Expt. Sta. Res. B. 219, 71 pp. 1960.

The potential productivity of the dominant soils in Northwest Wisconsin was analyzed to compare this potential productivity with that actually obtained on some of the "better-managed" farms.

This study attempts to answer the following questions: (1) What cropping practices are followed and why crop yields are now obtained on farms of the dominant soil types in northwestern Wisconsin? (2) What are the recommended cropping practices and potential yields on these soils? And (3) how might a shift from past to recommended cropping practices be expected to alter livestock production and net income on farms of the various soil types?

Review of related literature indicates that although many years of research have been devoted to determining crop response to fertilization and other cultural practices, only fragmentary data is available on actual yields obtained by farmers on the various Wisconsin soil types. Knowledge of actual yields under current practices, together with potential yields under recommended practices, is basic to sound farm planning. For maximum usefulness, such knowledge must be related to specific soil types. Thus, answers to the three questions posed above will give farm operators and professional advisors in the area a more realistic basis for planning changes in cropping systems.

Although the potential income improvement through adoption of recommended cropping practices is significant on all of the soils studied, it is particularly large on the following: Spencer, Waukegan, Antigo, Jackson, Onamia, Jewett, and Fayette. In general, these soils have the highest potential crop yields per acre. Many of the less productive soils are now operating more nearly to their capacity.

Regardless of the soil type, a farmer with past cropping practices and mediocre livestock would make the largest income gain by improving both crops and livestock. Annual net farm income can be increased by \$5,000 or more in this way on the more productive soils.

Simultaneous improvement of crop and livestock productivity through the adoption of superior management practices can be a tremendous boon to net farm income in northwestern Wisconsin. The soils of this area have high production possibilities.

Agr. Expt. Sta., U. Wisc., Madison, Wisc.

The business activity of 22 farms and ranches in northcentral Wyoming, in 1957 are described and analyzed.

The five dairymen made an average labor income of \$5,534 and a rate of return of 11.6 percent on an average capital investment of \$52,484. Comparable figures for the 12 general farmers was \$8,671 labor income and 10.6 percent return on \$124,079. In comparison, the 5 cattle ranches earned a labor income of \$3,085 and a return of 5.3 percent on \$235,032 total investment.

The dairy farms, general farms, and cattle ranches had a cropland investment per acre of \$147, \$171, and \$96, respectively. The respective investment per acre in improvements was \$77, \$49, and \$35.

The dairy farmers worked about 20 percent more hours per year than the general farmers. Their average cost per hour for labor was \$1.08 compared with \$1.33 for general farmers and \$1.29 for cattle ranches. The farmers who used their tractors only 356 hours per year had an annual cost of \$1.44 per hour compared with \$1.02 per hour when tractors were used 988 hours per year. The amount of annual use also influenced in a similar manner the cost of owning and operating farm trucks, autos, and farm machinery.

The average beef-cow enterprise on the five cattle ranches consisted of 253 cows which produced 347 lbs. of beef per cow and had an annual carrying cost of \$64.90 per cow. The returns per cow were \$66.77, leaving a profit of \$1.87 per cow and a labor return of \$1.67 for each of the 6.9 hours of labor required.

The five farm beef-cow enterprises averaged 60 breeding cows, 364 lbs. of beef per cow, and \$68.17 carrying cost per cow. The returns per cow were \$76.44, leaving a profit of \$8.27 per cow and a labor return of \$2.40 for each of the 7.4 hours of labor required.

The amount of beef produced per head greatly influences profits in beef production: With a 75 percent calf crop, the producers barely broke even and had a high cost per cwt. of beef of \$21.09. With a 90 percent calf crop, their cost of production was \$16.70 per cwt. and the profit was \$3.19 per cwt. or \$12.79 per cow.

Averages for the five commercial dairies were: \$469.96 gross returns per head, \$404.01 annual carrying costs per head, and \$65.95 profit per head. The break-even price per cwt. was \$4.07 and the break-even production was 8,500 lbs. of milk.

The average feed cost per cwt. of gain for beef feeders was \$17.98. There was a spread of only \$1.16 per cwt. between the sale price of fat steers and the purchase price of feeders. This was insufficient margin for the average beef feeder to break even.

Sugarbeets were the most profitable cash crop on irrigated farms. The average grower produced 19.4 tons per acre; he made a profit of \$123.27 per acre and a labor return of \$5.53 per hour. At \$15 per ton the break-even yield is 12 tons; at production costs prevailing in 1957 (\$180.47 per acre), the break-even price is \$9.03 per ton.

The cost of producing dry beans was \$59.42 per acre or \$3.28 per cwt. The profit per acre was \$46.56 and the return per hour of labor was \$5.61. It cost \$41.16 to produce an acre of certified alfalfa seed.

Barley showed a profit of \$14.21 per acre and a return per hour of \$2.56. The break-even price was \$0.87 per bushel. Wheat had a production cost of \$49.92 per acre, a profit of \$1.40 per acre, and a return per hour of labor of \$1.43. The break-even price was \$1.78 per bushel. Oats showed a loss of \$9.03 per acre and a return per hour of \$0.35.

The alfalfa hay growers averaged 2.5 tons per acre, had operating costs of \$36.83 per acre, and lacked \$0.77 per acre of paying all costs. The break-even price was \$14.73 per ton. Corn produced for silage cost \$83.29 per acre and the

returns for the 12.4 tons per acre were \$78.88, leaving a loss of \$4.41 per acre. The break-even price was \$6.72 per ton.

To produce sugarbeets yielding 19 tons per acre required the following inputs: 30 hours of labor, 5.2 lbs. of seed, 110 lbs. of available nitrogen, 12 tons of barnyard manure, 18 tractor hours, 60 truck miles, and 30 auto miles. Similar information is given for inputs for other crops.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

Gray, J. R. SHEEP ENTERPRISES IN NORTHERN NEW MEXICO. N. Mex. Agr. Expt. Sta. B. 454, 17 pp. 1961.

In a study of 10 sheep ranch enterprises in northern New Mexico in 1957-59, it was found that:

Sheep enterprise production rates in northern New Mexico mostly are lower than the production rates in southern New Mexico. Lamb weights and fleece weights are lower, and lamb crops and death losses are higher.

The investment in the northern New Mexico sheep enterprise is low \$30 per head; the labor per head is twice that used by southern New Mexico ranchers. Two of the major production problems of northern New Mexico sheep ranchers are getting competent labor and acquired control of sufficient grazing land.

Labor costs are the largest single item of cash expense, followed by feed costs.

Ranchers in northern New Mexico have not been able to take as full advantage of new techniques in sheep production as the southern operators. Partly responsible for this situation is that the operator is limited both in control over grazing lands and in capital.

The sheep enterprise yielded sufficient income over the 1957-59 period to pay all costs, including a 4 percent return on investment. On the average, operators received about \$1,300 in 1957, \$3,000 in 1958, and \$2,600 in 1959.

Lease fees per acre were highest for privately owned lands and lowest for state lands. The two major kinds of ownerships in north-central New Mexico were private ownerships and National Forests.

Although about a third of the rams used are the more active black-faced breeds, the 2 or 3 rams per 100 ewes are about half of that used in southern New Mexico and are still lower than the number in most western sheep-producing areas.

Grease fleece weights and lamb crops apparently improved in the 3-year period studied. Price received both for wool and lambs are lower than those received in southern New Mexico. Sheep operators have not pooled their lamb and wool products. Small quantities offered for sale by individual producers have not attracted much competitive bidding in the area for these products. Locating markets for lambs and wool are two of the major marketing problems in northern New Mexico.

N. Mex. State U., Agr. Expt. Sta., University Park, N. Mex.

Reeser, R. M., and Baker, R. H. COSTS AND RETURNS IN FEEDING LAMBS, OHIO, 1957-58 SEASON. Ohio Agr. Expt. Sta. Res. B. 884, 23 pp. 1961.

The costs experienced by 26 operators of commercial lamb feeding projects in central Ohio in the 1957-58 season averaged \$22.56 per lamb sold. The purchase cost of the feeder lamb accounted for 60 percent of this, or \$13.61. Death losses (6.2 percent of the lambs purchased) resulted in a mortality charge of \$0.68 on each lamb marketed. Feed made up 25 percent of costs or \$5.69, of which about one dollar was out-of-pocket expense for purchased feed and processing. Labor averaged 0.83 hours per head sold and represented 4 percent of costs. Other expenses made up 8 percent of the costs.



The returns from feeder lamb projects averaged \$23 per lamb sold. Of this, 89 percent came from sale of the lamb and 8 percent from wool. Manure credit made up the other 3 percent.

Net return averaged 44 cents per head sold.

Feed consumed per lamb sold averaged as follows: Grain, 168 pounds; hay, 145 pounds; and purchased feed (primarily protein and supplements), 15 pounds. Use of pasture was variable; only one-third of the operators used pasture for an average of a little more than 3 weeks per lamb.

The larger projects required much less labor per lamb, with the reduction occurring primarily in daily chore labor. The larger projects used less hay per lamb, but efficiency of feed utilization and the feed cost per pound of gain did not seem to be related to size of project. Large projects appeared to have certain advantages in marketing.

Self-feeding required less labor, particularly for daily chores. Self-feeding also had higher mortality. Hand feeding gave larger net returns. The advantages of self-feeding in regard to labor efficiency and faster rate of gain were more than offset by the disadvantage of higher mortality rates.

A tabulation of physical inputs and production as reported from 26 projects is presented, so that costs and returns can be calculated for any desired level of prices.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Kadlec, J. E., Kehrberg, E. W., and Dunbar, J. O. ORGANIZING A CENTRAL INDIANA HOG FARM USING LINEAR PROGRAMMING. Purdue U. Agr. Expt. Sta. B. 712, 15 pp. 1961.

The optimum farm organization for a 305-acre central Indiana farm was determined using linear programming. Twenty-five different hog enterprises and combinations of these enterprises were considered, together with alternative crop rotations and a beef feeding enterprise. The most profitable farm organization included: (1) Crop rotations--260 acres of a corn-corn-corn-corn-oats-meadow rotation, 45 acres of continuous corn, and purchase of 501 bushels of corn; and (2) livestock rotations--40 sows farrowed in January and July, 40 sows farrowed in February and August, and 12 sows farrowed in June.

Labor distribution was the major factor affecting the selection of the hog system. The system finally selected required the most labor during times when it was not needed for the cropping system, thereby making farm labor more efficient than it would have been with other farrowing systems. Returns over costs and limited farrowing facilities also affected the program selected but to a lesser extent.

Several other enterprises can be substituted for those in the maximum profit organization with little reduction in farm income: (1) Hog enterprises with farrowing and nursing times that do not conflict with heavy corn labor requirements in May, June, October and November; and (2) crop rotations with high percentages of corn, beans, and wheat.

The addition of May labor and October labor would result in a more profitable farm organization.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Terrill, S. W., Becker, D. E., and Jensen, A. H. MANAGING YOUR HOG BUSINESS. Ill. Ext. Serv. Agr. and Home Econ. C. 824, 31 pp. 1961.

The hog business is going through a revolution at the present time. Competition is forcing hog producers to cut production costs, to increase their volume of operations, and to pay more attention to the production of a high-quality product for the consuming public. The general trend is toward increased specialization,

drylot rearing, multiple or successive farrowings, and the use of complete rations.

When you go into the hog business in Illinois, you become part of a 450-million-dollar industry. This 450 million dollars represents one-fourth of the annual farm income in Illinois.

To manage your hog business successfully, you must make decisions and take action on all phases of the operation. These include breeding, feeding, hygiene, housing and equipment, and all areas of management. The important aspects of each of these phases are covered in this circular.

U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Wheeler, R. O., and McConnen, R. J. ORGANIZATION, COST, AND RETURNS COMMERCIAL, FAMILY OPERATED CATTLE RANCHES. Mont. Agr. Expt. Sta. B. 557, 19 pp. 1961.

A study was made of the organizational characteristics, cost, and returns to three sizes of commercial family-operated cattle ranches in the Northern Great Plains. The size classes were defined by the number of animal units on hand January 1, 1959. The major source of data was a survey of ranch operators in the area in 1959. The data were used in establishing the organization characteristics and most of the values for a budget analysis of a typical ranch unit within each size class presented.

The average number of acres per animal unit on hand January 1, 1959, was 30.93. Acres of cropland on the respective ranches were included in calculating the average carrying capacity. There tended to be an inverse relationship between percentage of deeded land in the ranch unit and the number of animal units on hand January 1, 1959.

The average cattle herd composition was made up predominantly of breeding cows and young heifers. About 70 percent of the total herd as of January 1, 1959, was breeding cows and young heifers.

The cash operating expenses were about \$38 per animal unit on hand January 1, 1959. There was no significant statistical difference in cash expenses per animal unit between the size classes of ranches studied. The larger ranch units tended to have a higher cash outlay for hired labor and rent per animal unit but had lower or equal cash expenses for all other cash expenses.

Using 1958-59 cattle prices, it was found that about 300 animal units (about 200 breeding cows) would be required for the typical ranch unit to return \$5,000 cash for labor and management.

FERD, ARS, USDA, and Mont. Agr. Expt. Sta., Mont. State Col., Bozeman, Mont.

Fryman, L. R. YEAR-AROUND STORED FEEDING FOR DAIRY CATTLE. Ill. Ext. Serv. Agr. and Home Econ. C. 826, 12 pp. 1961.

With high land prices, the pressure is on farmers to squeeze all of the production possible out of every acre in the farm. The days are gone when the dairyman can afford to use three or more acres of land to grow the forage for one cow. He must get higher yields of forage. A number of dairymen are looking to stored feeding as a means of obtaining higher forage yields.

During the summers of 1956, 1957, and 1958, dairy scientists at the University of Illinois demonstrated that dairy cows fed green chopped forage or silage in drylot produced as much milk as cows on excellent pasture. They found that the key to a successful summer-feeding program was to feed the cows as much high-quality forage as possible. It didn't make any difference in production whether the cows were on pasture or were fed green chop or silage as long as the forage was of good quality and the cows received enough of it.

When good-quality dry hay was added to the rations, production remained about the same in all three groups of cows. The cows simply ate less silage, green chop, or pasture while they were receiving the hay. This fact further demonstrated the possibilities of maintaining high production in a herd of cows kept in drylot the year around under Illinois conditions.

In 1960, the Department of Dairy Science conducted a survey of 86 Illinois dairy herds. Twenty-four of these herds were fed silage and hay (stored feeding) the year around. The survey showed that the level of production in these 24 herds was about the same as in the herds on summer pasture or green chopped forage.

The 24 farms on stored feeding used less land to grow the forage for one cow for the year than the farms using other systems of handling summer forage. The advantage in higher yields over the daily green-chopping plan and the daily rotational-grazing plan was small. There was, however, a considerable advantage over continuous grazing.

There are at least two reasons why fewer acres are required to grow the roughage for a cow under the stored-feeding plan than under the other plans in this survey. First, a higher percentage of corn silage is fed; and second, the grass-legume forage is harvested at a more desirable stage of development for maximum yields.

Number of Acres Required to Produce Forage for One Cow for One Year Under Five Summer-Feeding Systems

System	Number of acres to produce forage for one cow for one year	Percent of total forage acreage in corn silage	Average number of animal units in herd
Stored feeding.....	1.4	30	48
Daily green chopping.....	1.6	15	45
Daily rotational grazing.....	1.5	14	24
Weekly rotational grazing.....	1.9	10	35
Continuous grazing.....	2.0	8	32

#### Stored Feeding for Dairy Cattle

Number of Acres Required to Produce Forage for a 48-Cow Herd for One Year Under Five Summer-Feeding Systems and Bushels of Corn That Could Have Been Grown Under Each System, Using Continuous Grazing as a Base

System	Acres needed to grow forage	Bushels of corn that could have been grown on land not needed under each system
Stored feeding.....	67	$(96 - 67 = 29) \times 87 = 2,523$
Daily green chopping.....	77	$(96 - 77 = 19) \times 87 = 1,653$
Daily rotational grazing.....	72	$(96 - 72 = 24) \times 87 = 2,088$
Weekly rotational grazing.....	91	$(96 - 91 = 5) \times 87 = 435$
Continuous grazing.....	96	$(96 - 96 = 0) \times 87 = 0$



The characteristics, investments, costs, and incomes of 13 loose housing and 13 stall barn farms for the year 1959 were compared. The farms studied were matched as to breed, number of cows, production per cow, and market outlet and were selected to include small, medium, and large-sized businesses. All were specialized dairy operations. They were located throughout the state of Maine.

Each group of farms averaged 53 cows for the year. Stall barn farms kept an average of 42 head of youngstock and loose housing farms 44 head of youngstock. Milk cow herds ranged in size from 22 to 198 cows. Annual milk production was about 525 hundredweight per farm for both groups and milk production per cow averaged 9,897 pounds on stall barn farms and 9,948 pounds on loose housing farms. A summer pattern of milk production prevailed on stall barn farms compared with a fall-winter pattern on loose housing farms.

The important difference between the two groups of farms in field equipment was that all loose housing operators owned field choppers compared with 70 percent of stall barn farm operators.

The average stall barn farm had more acres of forage and pasture than the average loose housing farm. Stall barn farms had 236 acres of all crops compared with 183 acres on loose housing farms. In addition stall barn farms pastured 61 acres of aftermath compared with 33 acres on loose housing farms. Loose housing farmers devoted more acreage to grass silage and green chop than stall barn farmers. The loose housing farms had higher yields per acre on most crops.

An average investment of about \$16,500 in pole barns and milking centers was shown on five loose housing farms, compared with an average investment of about \$15,000 in stall barn and milk rooms on five farms with conventional tie-ups.

The equipment investment on loose housing farms was about 15 percent higher than on stall barn farms. The principal difference was in power equipment and was attributable largely to newer equipment.

Investment in milk cows, young stock, and bulls was about 10 percent higher on loose housing than on stall barn farms.

The investment in real estate, equipment, livestock, crops, and supplies amounted to \$1,617 per cow for loose housing farms compared with \$1,485 per cow for stall barn farms.

Returns to the operator for his labor and management were higher on the average stall barn than on the average loose housing farm. Net cash income was about \$6,000 per farm for stall barn farms and about \$5,000 per farm for loose housing farms.

Stall barn operators devoted 3,166 hours to the farm business and operators of loose housing systems 2,327 hours, resulting in labor incomes per hour of 87 cents and 72 cents for the respective operators.

Net income per hundredweight of milk produced was slightly higher for stall barn than for loose housing farms.

A 4 percent higher price was received for milk by loose housing than by stall barn farms. The stall barn farms received \$5.59 and the loose housing farms \$5.84 per hundredweight for stall barn and loose housing farms, respectively.

About 1,000 fewer hours of labor were devoted to cows on loose housing farms than on stall barn farms. On stall barn farms 84 hours of chore labor was used per cow compared with 67 hours of labor per cow on loose housing farms.

The high feed costs on loose housing farms were due to feeding more concentrates and more machine-harvested forages per cow, to purchasing more forage and using more fertilizer, machinery and labor in growing and harvesting forages than on stall barn farms.

The combined expenses for tractor, truck, auto, and dairy equipment used directly for milking herd chores were about 30 percent higher for loose housing than for stall barn farms.

Annual building costs were higher for loose housing than for stall barn farms both for the five pairs of farms selected for comparability as to size and building ages and for all 13 pairs of farms in the study. Annual building costs averaged \$22 per cow for all loose housing herds and \$17 per cow for all stall barn herds.

Loose housing farms had about 7 percent higher herd replacement costs than stall barn farms.

Cash expenses for bedding purchased amounted to \$76 per farm on stall barn farms and \$235 per farm on loose housing farms.

Maine Agr. Expt. Sta. U. Maine, Orono, Maine.

Magee, A. C., Stone, B. H., and Carpenter, S. E. PRODUCTION, PRODUCTION REQUIREMENTS AND COSTS, EAST TEXAS DAIRY FARMS. Tex. Agr. Expt. Sta. MP-486, 10 pp. 1961.

In East Texas, emphasis has shifted from cash crops to livestock, with dairying becoming the major enterprise on many farms. Such an adjustment has been accompanied with numerous management problems. These problems became increasingly important as milk prices were adjusted downward at the same time that production costs trended upward. Operations on approximately 100 representative dairies were studied to determine the costs and returns of producing milk.

Average annual milk production per cow in the milking herd greatly influenced production costs and in turn materially affected dairy profits.

The average annual production per cow for all farms studied was 6,240 pounds of milk. Ten percent of the herds produced less than 5,000 pounds of milk per cow annually and averaged 4,200 pounds. A similar percentage of the herds produced 8,000 pounds or more per cow.

At prices and costs that prevailed during 1959, cows producing only 4,200 pounds of milk did not pay all production costs. Operators with such low-producing herds were able to pay the cash operating costs, but were not providing for the replacement of their equipment and improvements and were working for a very low wage.

Cows producing at the average level (6,200 pounds of milk annually) paid for all operation costs, provided for interest on dairy investment, and for upkeep and depreciation, but paid the operator and his family only about 70 cents an hour for the time spent working with the dairy.

Under 1959 price conditions, a herd of 52 cows averaging 8,700 pounds of milk annually provided the dairy farmer and his family a labor and management wage of \$5,300.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Edwards, C., and Grubb, H. W. DAIRY FARM ORGANIZATION IN CENTRAL AND NORTHEAST OKLAHOMA. Okla. Agr. Expt. Sta. B. B-573, 30 pp. 1961.

Typical dairy farm organizations in central and northeastern Oklahoma are described and examined for potential for increasing profits. The methods of analysis used were to estimate the average efficiency of milk production for six sizes of farm in a sample of 44 dairy farms in central Oklahoma, and to use linear programming analysis to estimate the most profitable farm organizations obtainable subject to various land, capital, and productivity restrictions. Some finds of the study were: (1) The availability of investment capital is the greatest deterrent on expansion of individual dairy farms; (2) herd increases from one-fourth to one-third percent herd size are profitable when there is a 60 percent

equity in the beginning farm organization; (3) herd increases from one-half herd size are profitable when there is a 90 percent equity in the beginning farm organization; (4) when land is not available for expansion, slightly larger investments are needed to attain slightly lower incomes than when land is available at reasonable prices; (5) pasture land is more important than cropland in expanding the herds; (6) specialization in milk production is important in the most profitable organization of farm resources; (7) specialization is more important when land is scarce than when it is plentiful; (8) specialization is reached by discarding production of oats, wheat, replacements, and hay, in that order; (9) herds of 25 cows and less indicate little growth potential; (10) herds of 32 and 46 cows indicate some growth potential, but some difficulty may be met in meeting repayment schedules of borrowed funds; (11) herds of 60 and more cows have attractive growth potential; (12) labor income increases averaging 20 percent more than percent incomes can be reached when there is a 60 percent equity in the beginning farm organization; (13) labor income increases averaging 50 percent more than percent incomes can be reached when there is a 90 percent equity in the beginning farm organization; and (14) average hired wage rates as high as \$1.70 to \$2.00 per hour need not deter expansion.

Okla. State U., Agr. Expt. Sta., Stillwater, Okla.

Dawson, G. R. ECONOMICS OF DAIRY FARMING IN RIO GRANDE AND ESTANCIA VALLEYS OF NEW MEXICO. N. Mex. Agr. Expt. Sta. B. 435, 35 pp. 1961.

Sixty-eight dairy farms in central and southern New Mexico were analyzed in a 1-year study of the physical and financial management of the dairy enterprise.

To be profitable, a dairy farm must be at least a two-man business with a minimum of about 25 cows per man, have a production per cow of more than 8,500 pounds, and, when a major part of the feed is produced on the farm, sell at least 425,000 pounds of milk per year. If all of the feed is bought, the herd must contain at least 80 cows.

The average investment in real estate, livestock, machinery equipment, and feed was about \$110,000 per farm. The investment in real estate amounted to 58 percent of the total, and in livestock, to about 18 percent.

Milk production per cow varied widely between farms, ranging from less than 5,000 to more than 11,000 pounds and averaging 8,961 pounds of milk and 333 pounds of butterfat. Surplus milk production in the spring seriously affected farm incomes. Management practices to level out annual production are needed to avoid low prices for seasonal surplus milk.

Feed consumption per cow averaged 3,097 pounds of grain and concentrate, 5.2 tons of hay, and 3.6 tons of silage. Adding silage to the roughage tended to increase milk production. Feeding more than 1 pound of grain and concentrates for each 3 pounds of milk produced was generally not profitable.

Feed costs amounted to \$273 per cow or about 50 percent of the value of milk sold per cow. High feed costs were closely related to low labor incomes and were traceable in part to high prices paid for hay in the winter months.

Cost of producing 100 pounds of milk varied widely between farms, averaging \$5.88. About 50 percent of the farms had greater production costs than returns when a charge of \$3,000 was included for the value of the farm operator's labor.

Labor income, the operator's return after he pays all expenses, including interest on capital, varied widely between farms, and averaged \$4,031 per farm. One farmer in three had a loss for his labor income and, in some instances, for his capital investment. Cash expenses averaged \$41,000 per farm, of which \$17,000 was spent for feed. Farms that produced feed tended to have lower labor incomes than did the drylot dairy operations.

N. Mex. State U., Agr. Expt. Sta. University Park, N. Mex.



## Institutional, Educational, and Social Factors Affecting Conservation Farming

Strohbehn, R. W., and Timmons, J. F. OWNERSHIP OF IOWA'S FARMLAND. Iowa Agr. Expt. Sta. Res. B. 489, 36 pp. 1960.

A study was made by questionnaires and personal interviews to learn of the ownership structure of Iowa farms, and the finance methods owners use to acquire land in Iowa.

Farm ownership is becoming more concentrated among nonoperator landlords. These owners now control slightly more than half of all agricultural land. In 1946, they controlled 42 percent of the land. Comparisons of tenure groups reveal that owner-operators represent 32 percent of the owners but operate only 27 percent of the land. Part-owners represent 15 percent of the owners and own 11 percent of the land. Operator landlords represent only 5 percent of the land owners, while they control 10 percent of the land. Nonoperator landlords represent 48 percent of all owners but control 52 percent of the land.

Concentration of ownership by specific individuals remains constant. Average size of farms has increased. Enlargement of family farms to take advantage of lower production costs associated with advancing technology accounts for the growing farm size. A noticeable increase was found in the number of part-owner operators.

Advances in technology have added a new role to part-ownership by causing farmers to seek larger operating units. The 35-percent increase since 1946 in the number of part-owners, plus the shift to older age groups within the part-owner group, indicates that former owner-operators are renting additional land. Part-ownership now has a dual meaning. It may represent either young farmers climbing the ladder to full ownership or former owner-operators who are expanding their operating units.

Nearly one-third of the owners obtained ownership by methods involving gifts or inheritances. An additional 20 percent reported purchasing land from relatives, while the remaining one-half obtained ownership by purchasing land from nonrelatives or by other methods. The fact that landlords tend to benefit more from gifts and inheritances than owner-operators indicates that part of the landlord group has obtained ownership without actively seeking it.

The existing capital structure of Iowa agriculture has made it difficult for farmers to accumulate the required capital to purchase farms.

Credit sources are rather inflexible in their lending policies and do not adequately meet the needs of farmers seeking title to the land they operate. Individual lenders are increasing in importance as a source of credit, and so is low-equality financing made possible by land installment contracts with private lenders.

To insure continued success of the farm as an operating unit, specific farm property transfer plans should be made. Increased interest in transfer plans was evidenced by the fact that the number of owners with wills in 1958 was nearly double that of 1946. Three of five owners reported they had wills specifying how their property was to be distributed.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Hubbard, D. W., and Blanch, G. E. THE FARM-RANCH CORPORATION: A TOOL FOR FINANCIAL PLANNING AND MANAGEMENT. Oreg. Agr. Expt. Sta., Sta. B. 576, 31 pp. 1961.

In the search for better methods of agricultural management, considerable attention has been turned to the corporation as a useful form of business organization. Certain farmers and ranchers can simplify their financial planning and management by using the corporate form. This is particularly so in "estate management," the accumulating, maintaining, and transferring to the next

generation the "agricultural estate" with maximum production capacity and with minimum taxes, costs, and capital shrinkage.

The advantages of the corporate form of business organization are:

(1) Division of ownership is greatly simplified. A share of the whole farm-ranch unit is represented by readily divisible shares in the form of security certificates. (2) Transfer of ownership is greatly simplified. Corporate securities can be bought, sold, traded, or given as gifts without legally disrupting or breaking up the farm business. (3) Continuity of operation of the farm-ranch can be more easily assured, since a corporation's life can be perpetual. The corporation does not depend upon the life of a single individual. (4) Limited liability protects individual or other business property of stockholders from claims of liability against the corporation. Likewise the corporation is protected from personal claims made upon the stockholders. (5) Income taxes can be saved, in some cases, by incorporating, but these cases will be the exception rather than the rule for farm-ranch corporations. The corporation with its readily divisible and transferable certificates can make estate planning easier and possibly eliminate estate or inheritance taxes. (6) Raising outside capital may be encouraged with the use of corporate securities, although raising capital in this manner is still quite limited for family farm-ranch corporations. And (7) favorable tax treatment permits retirement and other "fringe benefit" programs to be developed by the business for stockholder-officers as employees.

The disadvantages of the corporate form of business organization are:

(1) Serious income tax disadvantages can occur unless care is taken to prevent them. (2) Incorporating means additional expense. Costs include lawyer and accountant fees as well as an incorporation fee and an annual license fee. A Federal stamp tax is in effect on issuance and transfer of stock. (3) A certain formality is necessary to incorporate, and additional recordkeeping and filing of reports is required. And (4) taxes and other considerations may make dissolution of a corporation an involved and expensive procedure.

Problems associated with business trends in farming and ranching, such as accumulating, maintaining, managing, and transferring capital, may require changes in the form of business organization in agriculture, if satisfactory solutions are achieved.

Oreg. State U. Agr. Expt. Sta., Corvallis, Oreg.

Mann, F. L., and Miller, F. DEED OF TRUST AS A FINANCING DEVICE IN PURCHASING MISSOURI FARM LAND. Mo. Agr. Expt. Sta. Res. B. 752, 14 pp. 1960.

The deed of trust is in general use as a security device in financing Missouri farmland transfers. It is used in transfers where a low downpayment is made, as well as in those where the conventional amount of 35 percent or more is paid down. It is also used whether the seller, an institutional lender, or someone else finances the transaction.

The popularity of the deed of trust in Missouri is due in part, especially in low downpayment transactions, to the legality of a nonjudicial foreclosure sale under Missouri law. Because of this law, the deed of trust provides a safe and economical means of foreclosure if the buyer defaults. At the same time, the buyer retains a sufficient beneficial interest to permit him to use the property as he chooses when he gives a deed of trust as security.

Satisfactory redemption periods can be provided for in the deed of trust, but the need for a specific time period may not be great. This fact is indicated by the lack of legal action by lenders in cases where the buyer had defaulted under the terms of the deeds of trust studied.

Because of the legal and practical advantages in Missouri of the deed of trust with power of nonjudicial sale over the installment contract, it is used almost exclusively in low downpayment transfers of farmland. It is also used in conventional



downpayment transfers where a conventional mortgage is used in other Midwestern States.

The data examined in seven counties of the State revealed no marked disadvantages in the use of the deed of trust. It is a convenient security device for both borrower and lender, but both parties should study the agreement carefully to be sure that it contains the specific provision they desire.

U. Mo., Agr. Expt. Sta., Columbia, Mo.

Elefson, R. V., and Raup, P. M. FINANCING FARM TRANSFERS WITH LAND CONTRACTS. Minn. Agr. Expt. Sta., Sta. B. 454, (North Central Reg. P. no. 122), 32 pp. 1961.

There has been an increase in the use of the installment land contract in the North Central Region in the past 15 years. Together with other similar forms of low-equity financing, including the deed of trust with power of nonjudicial sale and the low downpayment mortgage, the land contract has emerged as one possible aid in meeting the growing problem of financing land ownership in modern agriculture. This growth has been promoted by a number of parallel trends, including high and growing requirements for operating capital, increasing land prices and taxes on capital gains, a scarcity of good farms for rent, difficulties in financing farm transfers from generation to generation, and the problem of providing adequate retirement income while permitting the transfer of farm operating units in advance of the death of elderly owners.

If the land contract is to be used to best advantage, it is important that buyers and sellers understand their legal rights and responsibilities. A contract-financed sale provides a wide range of flexibility in adapting it to the needs of particular situations. This flexibility can be used to advantage only if buyers and sellers consider carefully the many factors that can contribute to the potential usefulness of this method of financing.

The following list includes the more important factors that should be covered explicitly in the contract: (1) Purchase price; (2) amount of the initial downpayment; (3) rate of interest; (4) type of payment plan; (5) length of the grace period within which any default can be remedied; (6) time at which possession is to be given to the buyer; (7) total time period covered by the contract; (8) prepayment privilege; and (9) conditions under which the buyer may obtain title by substituting a mortgage for the contract.

Agreement in writing covering these matters can make the difference between a farm sale that is advantageous to both buyer and seller and one that is costly to them in money, time, and effort.

If the provisions of the contract are to accomplish the desired ends, it is essential that competent legal advice be secured. The desires of the buyer and seller are frequently different and may be opposed. Each party should consult his own lawyer so that he can be sure that he is informed of the full implications of the agreement. The contract should be drawn up to fit the economic and agricultural situation to which it applies.

This bulletin covers the laws and practices of 13 States. Of necessity it has had to treat some complex issues in general terms. Specific legal provisions vary from state to state. The full usefulness of the bulletin will be realized only if it is supplemented with up-to-date information from state and local sources.

North Cent. Region, and U. Minn., Agr. Expt. Sta., St. Paul, Minn.

Harmon, M. B., and Harris, M. YOUR FARM LEASE CHECKLIST. U. S. Dept. Agr. Farm. B. 2163, 11 p. 1961.

A farm lease checklist that can be used by owner and/or tenant to make sure that a suitable lease will be drawn up for the farm to cover all suitable conditions.

ARS, USDA, Inform. Div., Washington 25, D. C.



Few farmers can afford to be without property and liability insurance. Larger operations, more capital investment, and higher court judgments increase the need for protection. Many farmers believe that medical and hospital bills and income lost because of disability should be covered, at least in part, by insurance.

Insurance is like a jigsaw puzzle--all of the pieces must be fitted together to get a complete picture. The proportions of the picture vary with each farmer, depending on the size and type of farm business, the land, cattle, machinery, and other property he owns, his age, and the number of dependents in his family.

This circular will help to determine the needs for insurance other than life insurance and to decide what types to buy.

The items to consider covering with insurance include: (1) Buildings; (2) liability for injury to employees; (3) liability for injury to outsiders; (4) medical and hospital expenses for injury to farmer and family; and (5) loss of income because of extended sickness or disability.

U. Ill., Col. Agr., Ext. Serv. Agr. and Home Econ., Urbana, Ill.

Baker, C. B., and Irwin, G. D. EFFECTS OF BORROWING FROM COMMERCIAL LENDERS ON FARM ORGANIZATION; WITH PARTICULAR REFERENCE TO FERTILIZERS, BUILDINGS, MACHINERY, LIVESTOCK, AND OPERATING EXPENSE. Ill. Agr. Expt. Sta. B. 671, 28 pp. 1961.

To study the effect of borrowing on the farmer's ability to get an optimum set of resources for his farm organization, two sets of estimates were made. First, the optimum use of resources was estimated for a specific farm in each of two areas--a grain area and a livestock area. Then estimates were obtained of the amounts of money that could be borrowed for resources for each farm.

The two sets of estimates were compared to determine how the amount of controllable resources compared with the most profitable amount for the farm. In both areas, more than enough funds were available for livestock and machinery. On the average, enough could be obtained for fertilizer and buildings, but there was not enough money in either area for operating expenses.

The amount of money that could be borrowed varied widely between purposes. The largest loan in both areas could be obtained for feeder-cattle purchase. The smallest in the livestock area was for fertilizer, and in the cash-grain area, machinery. Large amounts of manure may reduce fertilizer needs in the livestock area. Experience with overinvestment in machinery may have conditioned grain-area lenders against this type of loan. Many lenders preferred to have machinery purchased on contract, and to finance the machinery dealer.

There were also differences between areas. Livestock lenders gave more weight to asset-creating loans than did lenders in the grain area. This apparently greater emphasis on collateral may be the result of more experience with feeder-cattle loans, which create assets. Grain-area lenders, on the other hand, have much more lending experience with fertilizer and operating expense, so they tend to discount these loans less and are willing to take other assets as collateral. These factors may also explain the higher machinery loans in the livestock area.

Production credit associations in both areas offered larger loans for machinery and buildings than did banks. The production credit associations were able to do so because they make 2- or 3-year loans, while banks ordinarily offered only a 1-year term with renewal.

No systematic variation was detected in terms of loan resulting from varying proposed use of funds. However, terms did vary between lenders, and for borrowers from the same lender with different asset positions.

TVA, and U. Ill., Agr. Expt. Sta., Urbana, Ill.

There are many different ways of getting established in farming. This study was principally concerned with how typical farm families become established. In recent years, farm partnership has become one of the most important routes. It gives the young farmer opportunity to get valuable experience by working with his father or someone else before buying a farm of his own. With a farm partnership, because of the opportunity for better balance of capital and labor, the son is usually able to accumulate farm operating capital--machinery, livestock, and cash savings--faster than if he were starting as a wage hand, cropper, or tenant. One disadvantage to this method of getting established is that many times the young farmer does not get the management experience on the home farm that he would likely get away from home.

Employment off the farm is an important way of becoming established, but only a few young families deliberately set out on this route.

For many years, the conventional route to farm ownership, usually called the "agricultural ladder," was that the young farmer started out as a wage worker on either the home farm or a nearby farm. After a number of years of this type of labor, enough capital was accumulated to purchase the livestock and equipment necessary to rent a farm. As a tenant, he had to spend more time accumulating capital before he could buy a farm. This route is decreasing in importance as a means of getting started in farming.

One method of getting started in farming is the father-son partnership, tenant, owner route.

The farmer is considered to be established when, on the average, in good years and bad ones, he is able to make a good living from the farm for himself and his family; and when he has reasonable secure control of the land and operating capital which he uses.

A farm family to be established as a farm owner-operator in a tobacco-livestock farming area in Kentucky would be expected to have a farm of about 100 acres or more, including around 65 acres of productive cropland, capable of use in a 4-year rotation or an equivalent acreage in longer or shorter rotations. The farm would be equipped with the necessary buildings and equipment for the production of the amount of tobacco and livestock which would utilize about 2,500 hours or more of productive man labor. Under conditions existing in the 1950's, the gross cash income would be expected to total \$3,000 or more. The business indebtedness of the farm family would be less than 50 percent of the value of livestock and machinery, and less than 65 percent of the agricultural value of the farm real estate. The farm operator would also be expected to have 3 to 4 years of management experience, an above-average level of education, and average or better managerial ability.

To be established in farming as a tenant operator--in addition to having the land, buildings, livestock and equipment outlined above--the tenant would be expected to utilize about 2,500 hours or more of productive man labor on the farm he rents. The business indebtedness would be less than 50 percent of the total value of his livestock, and he would own free of debt practically all the needed farm operating equipment. The tenant would have management ability above average and would share in all the commercial enterprises on the farm.

It is usually a good thing for young farm families to go in debt, if necessary, for developing the farm business. It is highly desirable for the farm family to be in debt less than about 25 percent of the value of machinery and less than 65 percent of the agricultural value of real estate. The most important factor in becoming established in farming is to find and buy, rent, or develop a farm business large enough to furnish profitable employment for the farm operator, and to provide sufficient gross income to pay operating expenses, make annual payments on indebtedness, and have enough income left for an adequate family living.



Factors affecting job mobility and migration in a high income rural community were analyzed. Job mobility refers to a change in type of employment. Migration refers to movement from one community to another. Dual mobility involves a change both in type of employment and in community. Mobility may be either voluntary or involuntary, depending on the relative importance of those factors beyond the individual's control in bringing about the particular change in employment or community.

A comparison of job-mobile and non-job-mobile individuals revealed that mobile persons were more likely to be younger, have lower incomes, and lower social status.

The motivation to change jobs differed among mobile individuals. Lower income people were primarily motivated by a desire for economic betterment. Younger and lower status individuals were motivated largely by a desire to improve in social status.

Migrant individuals tended to be younger, have lower incomes, have more education, and come more frequently from middle social strata than did the non-migrant individuals.

Dual mobility (job mobility and migration) tended to be high among the younger members of the sample and the college educated.

There appeared to be a dominant motivation associated with each type of mobility. Job-mobile individuals were strongly motivated by desires for economic improvement. Migrants were primarily motivated by desires for social betterment, the job-mobile and migrant persons were motivated by desires for both economic and social improvement.

Voluntarily mobile individuals typically moved into occupations which made use of the capital and managerial skills they had previously used in farming. Involuntarily mobile persons moved primarily into semiskilled and unskilled jobs.

Voluntarily mobile individuals were younger, better educated, and had higher social status and managerial ability than the involuntarily mobile individuals.

The characteristics associated with each type of mobility suggest that the largest proportion of involuntary job mobile population, while the largest proportion of voluntary job mobility occurred within the dually mobile population.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

Taylor, M. M. THE CONSERVATION RESERVE PROGRAM IN NEW MEXICO. N. Mex. Agr. Expt. Sta. Res. Rpt. 54, 25 pp. 1961.

The operation of the Conservation Reserve Program and its effects in selected New Mexico counties is discussed. The study was based on personal interviews in 1959 with 247 farm operators in Curry, Roosevelt, and Torrance Counties in east-central New Mexico.

The weather of the study areas varies greatly. Severe drought is common. Crop yields in the areas also vary greatly. The principal crops in the Curry-Roosevelt area are grain sorghum and wheat. In Torrance County, the main crops include alfalfa, potatoes, sugar beets, dry beans, grain, and sorghum. For the past several years, most of the crop production in the two areas has been from irrigated land. Livestock, mostly cattle, are important in both areas.

Farm population and number of farms in the study areas have decreased over the past 20 years, while average size of farm has steadily increased.

The farm operators were chosen at random and grouped as full participants, part participants, and nonparticipants. Most farmers own at least part of the land they operate. About 23 percent of the farm operators in the Curry-Roosevelt area did not own any land; in Torrance County the proportion was 16 percent.



There is more participation in the Conservation Reserve Program in New Mexico than in most states. Nearly 40 percent of the cropland in the Curry-Roosevelt area and 73 percent of the cropland in Torrance County were in the program in 1959.

Contract rental rates averaged \$9.05 per acre in the Curry-Roosevelt area and \$5.74 in the Torrance County area for the period 1956-59.

Most Conservation Reserve Program contracts are written for 10-year periods, and most of them are scheduled to expire in 1965-67. More than 520,000 acres of cropland were under contract in the two areas in 1959. Virtually all of this acreage is dry cropland.

Operators who have all of their cropland in the program are older than the others. Those who have only part of their land in the program tend to be older than those who do not participate in the program.

A higher proportion of full participants than of part participants and non-participants lived off their farms.

Part-participant farms contained considerably more cropland than either full or nonparticipant farms. Full participant farms had somewhat less machinery and fewer usable buildings than part-participant and nonparticipant farms.

Drought was the main reason given by participating farm operators for contracting land under the program. The principal reason nonparticipants did not contract land under the program was that they felt they could make higher net returns by raising crops. Much of their land was irrigated.

More than one-half of the participants in the Curry-Roosevelt area and 70 percent in the Torrance County area plan to leave their contracted land in permanent vegetation when their contracts expire.

Seeding to grass has been the only cover practice adopted in the study areas. This practice has been quite successful in the Curry-Roosevelt area, but has met with only fair success in Torrance County.

Quality of the dryland does not differ greatly from participating to nonparticipating farms.

New Mex. State U., Agr. Expt. Sta., University Park, N. Mex.

## BIOLOGY

### Fish

Snow, J. R., and Jones, R. O. CHANGES IN WARM-WATER PONDS AFTER HYDRATED-LIME APPLICATIONS. Prog. Fish-Cult. 23: 51-60. 1961.

The effects of hydrated-lime ( $\text{Ca}(\text{OH})_2$ ) additions made to produce a theoretical bottom-soil pH of 7.0 were studied over a 3-year period. Use of specified amounts of lime did change the bottom-soil pH to 7 or slightly higher within a 6-month period in all the ponds treated. Changes in the bottom soils were not rapid, even though drastic chemical reactions occurred in the water of ponds where quantities in excess of 1,800 pounds of hydrated lime per acre were added. A high degree of hydroxide alkalinity was noted shortly after the lime was applied, with pH readings as alkaline as 12.0 being measured 1 day after liming.

The effect of lime on the bottom soil appeared to be temporary, as the highly acid ponds were returning to their former state of acidity 18 months after being limed to a neutral condition.

Use of lime in alternate years was needed in ponds where a highly acid condition existed before liming, if a pH of 7.0 was to be maintained. In ponds where little lime was needed initially, the bottom-soil pH remained more stable after treatment with lime.

Higher rates of liming eliminated practically all bottom organisms and higher vegetation in the ponds. Bottom samples taken from a pond a week after application of 1,810 pounds of hydrated lime per acre contained no living organisms big enough to be seen with the unaided eye. Rooted aquatic life recovered rapidly as a bloom of phytoplankton was seen in a few days, and some bottom organisms--dragonfly nymphs, mayfly nymphs, and midge larvae--were found in samples collected 3 weeks after treatment.

Phytoplankton, as measured by increased pond-water turbidity, was more abundant in the limed ponds than in the unlimed ones and was increased further by the addition of superphosphate.

Bur. Sport Fisheries and Wildlife, Marion, Ala.

Cordone, A. J., and Kelley, D. W. THE INFLUENCES OF INORGANIC SEDIMENT ON THE AQUATIC LIFE OF STREAMS. Calif. Fish and Game 47: 189-228. 1961.

There is abundant evidence that sediment is detrimental to aquatic life in salmon and trout streams. The adult fishes themselves can apparently stand normal high concentrations without harm, but deposition of sediments on the bottom of the stream will reduce the survival of eggs and alevins, reduce aquatic insect fauna, and destroy needed shelter. There can scarcely be any doubt that prolonged turbidity of any great degree is also harmful.

Many of the sediment problems reported in literature are the result of large-scale discharges of sediment from gravel washing or mining operations. These are spectacular but probably less important than the gradual deposition being caused by erosion.

The increasing activity of man on our mountain watersheds in California is resulting in obviously increased erosion and sediment deposition. Our failure to recognize that even small amounts of sediment may be harmful may result in gradual destruction of the majority of our streams.

Experience in the Sierra Nevada indicates that the bulk of the damage there is unnecessary. It can be prevented with known land use methods, often with little or no additional expense. Much of it is the result of carelessness.

We need to develop a philosophy of land husbandry that will avoid the creation of untreated and running sores on the earth's surface. Man must acquire a responsibility to future generations that matches the power he has gained through the development of heavy machinery.

Observations in the field and review of the existing literature leads to the conclusion that unless this can be done, many of our trout streams will be destroyed by the deposition of sediment.

Inland Fisheries Br. Calif. Dept. of Fish and Game.

Gebhards, S. V. EXOTIC FISHES--GOOD OR BAD. Idaho Wildlife Rev. 13(6): 3-5. 1961.

There are over 700 species of freshwater fishes in North America. The use of exotic fish in a state can reduce the possibilities from 700 to a few dozen by the use of the following standards:

1. It must be a game fish that will provide good catchability.
2. All of the habitat requirements of a species, including water chemistry, physical features of the environment, water temperatures, food and spawning areas must be carefully evaluated. Many plantings of exotics have either failed completely or backfired and produced stunted populations because one or more of the habitat requirements were lacking, or below optimum.

3. Exotic species should not be competitive with other desirable species to the extent that they become a nuisance, or undesirable.
4. Planting sites should be selected so that a species cannot migrate into other waters where they may become a problem.
5. The species should be self-perpetuating and not dependent upon annual restocking. This can go to other extremes if fish with high reproductive potentials are not subjected to predation or heavy fishing pressure.
6. If the species must be restocked periodically, costs of producing, transporting, rearing, and planting should be on an economical basis.

A compilation is given of the following species listing their native range, habitat requirements, and desirability in Idaho waters: Landlocked salmon, kamloops, mackinaw, brown trout, brook trout, golden trout, Montana grayling, muskellunge, northern pike, walleye, yellow perch, largemouth bass, smallmouth bass, black crappie, bluegill sunfish, green sunfish and pumpkinseed, bullhead, and channel catfish.

Fishery Biol. Idaho Fish and Game Dept., Boise, Idaho.

Soil Conserv. 26 (8): 171-190. 1961.

This issue of the Soil Conservation Magazine is devoted to wildlife production and contains the following articles:

Williams, D. A. WILDLIFE CONSERVATION IN THE SOIL AND WATER CONSERVATION PROGRAM. SCS, USDA, Washington, D. C.

Pavelek, H. J. WILDLIFE FARMING IN OREGON. SCS, USDA, Albany, Oreg.

Mayville, A. G. NOT WORTH THE TAXES. SCS, USDA, Middleburg, Va.

Dierks, E. STRIP MINE BECOMES WILDLIFE HAVEN. SCS, USDA, Washburn, N. Dak.

Sedgley, E. F., and Boeker, H. M. 1,500 CATTLE AND 100,000 DEER. SCS, USDA, Meeker, Colo.

Hypes, W. M. TROUT POND IN VIRGINIA. SCS, USDA, Staunton, Va.

Roth, B. A. WAY DOWN EAST--FISH ARE SOIL SURVEY "CUSTOMERS". SCS, USDA, Upper Darby, Pa.

Gowder, L. E. BEAVER POND GROWS DUCK FOOD. SCS, USDA, Eutaw, Ala.

Nehoda, J. HUNTING ON THE CONTOUR. SCS, USDA, Greensburg, Pa.

Koerner, R. O. RANGE AND WILDLIFE MANAGEMENT ON A SOUTH DAKOTA RANCH. SCS, USDA, Onida, S. Dak.

Ruona, W. A. NEW HOME FOR DUCKS. SCS, USDA, Detroit Lakes, Minn.

Cheney, H. V. PHEASANTS--BY THE HUNDREDS. SCS, USDA, Dove, Kans.

Coughran, J. MORE QUAIL AND DEER ON A TEXAS RANCH. SCS, USDA, Tilden, Tex.



Latham, B. M. CATFISH FARMING. SCS, USDA, Anderson, S. C.

Rushing, D., and Fisher, R. D. COTTONTAILS AND BOBWHITES ON A CATTLE FARM. SCS, USDA, Dyersburg, Tenn.

Cope, O. B. EFFECTS OF DDT SPRAYING FOR SPRUCE BUDWORM ON FISH IN THE YELLOWSTONE RIVER SYSTEM. Trans. Amer. Fisheries Soc. 90(3): 239-251. 1961.

DDT was sprayed at 1 pound per acre from airplanes for the control of spruce budworm on 71,678 acres in the Yellowstone River drainage in 1957. Stream-bottom invertebrates were reduced in number immediately after the spray. Recovery to near-normal total numbers occurred within a year in most streams, but species composition was altered. Drift samples in one stream showed dead and dying invertebrates to be drifting in the current in great numbers. No mortality to fish was found. Chemical analysis showed that DDT up to 0.03 p.p.m. was in several samples of water from streams. In one case, a trace was found 55 miles downstream from the spray area. Vegetation samples contained up to 2.3 p.p.m. of DDT. All of the 80 samples of mountain whitefish (Prosopium williamsoni), and rainbow trout (Salmo gairdneri), and brown trout (S. trutta) analyzed contained either DDT up to 14 p.p.m. or DDE up to 6.53 p.p.m., or both. DDT was found in trout 85 miles below the spray area, and fish taken more than 2 years after spraying contained DDT.

U.S. Bur. Sport Fisheries and Wildlife, Denver, Colo.

### Upland Wildlife

Rudasill, L. S. HELP FOR HOMELESS SQUIRRELS. Outdoor Amer. 26 (5): 10-11. 1961.

The making of squirrel nests out of discarded ammunition boxes is described and illustrated. The boxes are placed 10 to 40 feet high in trees in woods where few or no den trees are available about 250 feet apart or one to each 1 to 1-1/2 acres.

The simple method of making and erecting the nesting boxes in Maryland is helping the squirrel management program. Providing additional homes has lessened competition among animals for dens and has developed better habitat, improved farmer-hunter relationships, and provided conservation education opportunity for the average people of the state.

Wildlife Field Supt., Md. Game and Inland Fish Comn., Baltimore, Md.

Biswell, H. H. MANIPULATION OF CHAMISE BRUSH FOR DEER RANGE IMPROVEMENT. Calif. Fish and Game 47: 125-144. 1961.

The extent to which deer populations increase with brush cover manipulation, and of methods of developing and improving brushlands for deer were studied. An opened area of brushland was compared with one of heavy untreated brush as a control, and with another burned by wildfire.

Deliberate opening of chamise brushlands in spots made for a favorable interspersed of grasses and forbs, browse, and cover. Deer populations in summer, in opened brush, were about three times greater than those in heavy untreated brush. Populations in a wildfire burn were about equal to those in opened brush for a few years after the fire but then gradually declined as the brush grew back toward its former mature condition.

The general objective in the manipulation of chamise brushlands for game should be to reduce the brush cover in spots and introduce palatable herbaceous species for use in winter and early spring. Methods for doing this are controlled burning and grazing, mechanical means (bulldozing and disking), and chemical treatment. Usually a combination of these methods will serve best. Reseeding to desirable forage and watershed plants should follow in places where brush has been removed by burning and disking.

U. Calif., Berkeley, Calif.

Julander, O., Robinette, W. L., and Jones, D. A. RELATION OF SUMMER RANGE CONDITION TO MULE DEER HERD PRODUCTIVITY. J. Wildlife Mangt. 25: 54-60. 1961.

Productivity of two mule deer herds in Utah and Idaho was studied; the severely depleted Antimony Mountain summer range in central Utah, and good summer range on the Sublett unit in southern Idaho.

Fall weights of Antimony fawn bucks and does were only 72 and 65 percent, respectively, of weights of the Sublett Fawns. Weight ratios of yearlings were 72 percent for bucks and 82 percent for does. For 2-year-olds, the comparable ratios were 74 and 85 percent; and for older deer, the ratios were 85 and 90 percent.

Average ovulation rate per doe on the depleted range (1.31) was only 67 percent of that on the good range (1.95). Fetal rate per doe averaged 1.19 for the Antimony compared to 1.85 for the Sublett.

A good summer range, capable of carrying deer in good condition through the breeding season, is necessary for maximum herd productivity.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Harper, H. TREE AND SHRUB PLANTINGS FOR WILDLIFE HABITAT IMPROVEMENT. Idaho Wildlife Rev. 13 (5): 6-9. 1961.

A Cooperative Program between the landowners, the Soil Conservation Service, and the Idaho Fish and Game Department is described that provide food and shelter for game species. The regular procedure is as follows:

1. The Soil Conservation District work unit conservationist keeps a record of those farmers who need or are interested in a tree and shrub planting;
- (2) upon notification by the Soil Conservation District, Department technicians contact the interested landowners in the cooperating Soil Conservation Districts;
- (3) the Department technician designs the planting and makes the agreement with the landowner;
- (4) the cooperating landowner prepares the ground for the planting;
- (5) the Department planting crew provides the seedlings and plants them; and
- (6) the cooperating landowner cultivates and irrigates the trees as needed to assure survival, growth, and permanent establishment.

Approximately 25 different species are available for use in the tree and shrub plantings. Over 100 species have been tested to determine their suitability. In addition to the quality of cover provided, the food value provided by the fruit of the tree or shrub is taken into consideration.

A sound, well-planned tree and shrub planting program will go far toward the objective of restoring wildlife habitat on Idaho farmlands. In addition to providing benefits for wildlife, the landowner realizes worthwhile results from these wind-break plantings. Wind velocity is reduced adjacent to buildings and feedlots. The windbreaks result in banks of snow which, when they melt, furnish additional ground moisture seeping into the soil.

Light, sandy soils are protected from wind erosion, sprinkler irrigation systems are made more efficient, and erosion is prevented in waterways. Last but not least is the beautification of the farm itself.

Through the tree and shrub planting program, the Department is attempting to make living conditions more favorable for wildlife and at the same time, and at no extra cost, provide better conservation measures on the soil resources that are so vital to everyone's existence.

Land Mangt. Supervisor, Idaho Fish and Game Dept., Boise, Idaho.

Ripley, T. H., and Campbell, R. A. BROWSING AND STAND REGENERATION IN CLEAR- AND SELECTIVELY-CUT HARDWOODS. 25th North Amer. Wildlife Conf. pp. 407-415. 1960.

Two tracts of typical mountain hardwoods (70 and 84 acres) on the Pisgah National Forest were clear and selectively cut in 1949 to observe browse production-utilization and regeneration of seedlings and coppice growth. Since the installation of treatments, the Forest has supported relatively high deer populations.

Two years after cutting (1951), the total number of seedlings and single stem sprouts on the clear-cut area was approximately twice that of the selectively-cut area. This first appraisal also indicated substantially lower utilization of browse in the clear-cut area.

Ten years after treatment (1959), the stands were remeasured to appraise changes in browse and regeneration conditions in the developing seedling and coppice stands. On the selectively-cut area, the stocking of commercially valuable seedlings and single stem sprouts was less than a third that of the clear-cut area. A significant difference was found in composition of the regenerating stands--in the main, more favorable in the clear-cut area. Yellow-poplar, a favored browse species, occurred with a significantly higher number of stems per acre in the clear-cut area (490 vs. 149). Although moderately heavy browsing was evident in the clear-cut area, the selectively-cut area appeared to be severely, if not overly, used.

All facets of the data tend to support the thesis that more browse was produced in the clear-cut area than could be consumed by deer--thus permitting the establishment of satisfactory regeneration. The relatively large size of the area and succulence of coppice regeneration may have been factors that contributed to the differences observed. The data suggest that clear cutting may offer an opportunity of enhancing timber and deer resources simultaneously.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Gysel, L. W. BULLDOZING TO PRODUCE BROWSE FOR DEER. Mich. State U. Q. B. 43(4): 722-731. 1961.

A tractor with a bulldozer blade was made to push down all or part of the woody vegetation in different plant communities to increase the amount of browse for deer.

In the sapling sugar maple stand, 1,260 pounds per acre of browse was available five growing seasons after the bulldozing; the check area had 99 pounds. Browsing was heaviest on stump and seedling sprouts, intermediate on epicormic branches, and lightest on crown branches. These preferences may result from differences in chemical content.

The amount of browse, after five growing seasons, in the oak type was 866 pounds per acre from a few oaks and red maples. Approximately two-thirds of the bulldozed trees died. Browsing occurred mainly on stump sprouts of red maple and white oak.

By the end of the second growing season after bulldozing in the red maple stand, numerous epicormic branches and stump sprouts had developed and were heavily browsed. One-half of the bulldozed tree boles were alive at the end of five growing seasons. Most of the browsing at this time occurred on the numerous stump sprouts.



The composition of the stand which was developing in the bulldozed willow plot was similar to that in the undisturbed check plot. Very little palatable browse was available.

In the bulldozed sumac plot, the composition of the plant community which was developing was similar to that in the check plot. Vigorous sumac sprouts and new growth of blackberry provided much browse.

Bulldozing is one method for producing large amounts of deer browse in some plant communities in the Pine River Experimental Forest area. This method could be used as a management procedure in sapling-pole sugar maple stands, and in areas in which staghorn sumac is a dominant plant species.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

Madson, J., and Kozicky, E. THE PRINCIPLES OF GAME MANAGEMENT.\*  
Pennsylvania Game News.\*\*

I. Hunting Regulations.	32 (1): 21-24. 1961.
II. Predator Control.	32 (2): 16-19. 1961.
III. Game Refuges.	32 (3): 30-32. 1961.
IV. Stocking	32 (4): 34-36. 1961.
V. Habitat Restoration.	32 (5): 36-38. 1961.
VI. Game and Habitat Analysis	32 (6): 36-38. 1961.

A series of six articles on game management mostly from the State Fish and Game Department standpoint.

Pa. Game Comn., Harrisburg, Pa.

Hungerford, C. R. WATER REQUIREMENTS OF GAMBEL'S QUAIL. 25th  
North Amer. Wildlife Conf. Trans. pp. 231-238. 1960.

In a study to see if Gambel's quail are capable of surviving without supplemental water during the dry seasons in southern Arizona, the following conclusions were reached by the author: (1) Native southern Arizona Gambel's quail show a dependence on moist succulent plant foods. (2) Quail without access to any moisture source other than from such foods have good survival and reproduction. (3) The calculated moisture requirement of the Gambel's quail appears to be fulfilled by the measured moisture content of natural food items. These quail also have behavioral adaptations to conserve body moisture. Known and possible physiological adaptations to conserve moisture were discussed. And (4) Gambel's quail can and do subsist well without free water in southern Arizona and rainwater catchments designed for this species alone are considered non-essential.

U. Ariz., Tucson, Ariz.

Reid, V. H., and Goodrum, P. D. BOBWHITE QUAIL: A PRODUCT ON LONG-LEAF PINE FORESTS. 25th North Amer. Wildlife Conf. Trans. pp. 241-250. 1960.

In this forest quail study in southwestern Louisiana, marked fluctuations in annual production and populations were recorded. The better winter bobwhite populations were significantly related to high reproductive success the preceding nesting season. The population trend was much the same on hunted and unhunted longleaf pine range, and the percentage of young birds found on an area protected from hunting for 14 years closely approximated that for the surrounding annually hunted area. One of the best reproductive seasons had a good late quail hatch. Significant relationships were found between annual production and temperature

and between annual production and precipitation records for the preceding summer months. In general, the best quail crops followed cool moist summers while poorest reproductive success followed hot dry summers. Temperature and precipitation readings during the warm-month period may be useful criteria for predicting annual quail production and winter populations.

Bur. Sport Fisheries and Wildlife, Fort Collins, Colo.

Lord, R. D., Jr., and Casteel, D. A. IMPORTANCE OF FOOD TO COTTON-TAIL WINTER MORTALITY. 25th North Amer. Wildlife Conf. pp. 267-274. 1960.

The importance of food to the winter mortality of cottontail rabbits on two study areas in central Illinois was tested by supplying them with commercial rabbit food on alternate years. The winter mortality was calculated by two methods.

The rabbits ate considerable quantities of the food but received no benefit from it, either in the form of a gain in body weight or in reduction of the large winter mortality rate.

It was concluded that for the areas studied, lack of sufficient food was not an important factor, either directly or indirectly, in the winter mortality of the cotton tail rabbits.

Ill. Natural Hist. Survey, and Dept. Conserv., Urbana, Ill.

Linder, R. L., Lyon, D. L., and Agee, C. P. AN ANALYSIS OF PHEASANT NESTING IN SOUTH-CENTRAL NEBRASKA. 25th North Amer. Wildlife Conf. Trans. pp. 214-229. 1960.

A nesting study was conducted on the Harvard Study area in south-central Nebraska from 1955-1959. Objectives were to evaluate the importance of various cover types in the production of chicks and the role of chick production in relation to changes in population.

The average breeding population of hens was 144, as determined from aerial and ground counts.

During the 5 years, 622 nests were found, 260 of them on sample plots. The number of nests on plots was projected to determine the total number established in each cover type.

Nearly 90 percent of the nests on the area were located in wheat, roadsides, and alfalfa; about 90 percent of the total production of chicks came from nests in wheat and roadsides.

In a hypothetical "average year", 144 hens established an average of 2.9 nests each. Sixty-three (44 percent) of the hens produced young, and 7.8 chicks hatched from each successful nest. An average of 496 chicks or 3.4 chicks per hen (based upon the entire breeding population) was produced each year.

Extensive renesting occurred on the study area. There was a greater incidence in renesting during years of population increase.

The percent of hens successful in producing young was the factor most closely related to the fluctuations in the rate of production of chicks from year to year.

Throughout the study, each year's breeding population correlated closely with the preceding year's production and the average number of chicks produced for each hen seemed to offer a key to predicting increases or decreases in the following spring's populations. A production index of 3.0 young per hen seemed to represent a threshold; when this figure was not attained, the following spring's population declined and when exceeded, the breeding population increased.

The quality of the nesting environment appeared to determine the number of nests which would be successful in a given year; this regulated production which in turn determined the level of the following year's breeding population.

Nebr. Game, Forestation, and Parks Comm., Lincoln, Nebr.

Trautman, C. G. EVALUATION OF PHEASANT NESTING HABITAT IN EASTERN SOUTH DAKOTA. 25th North Amer. Wildlife Conf. Trans. 202-213. 1960.

Information on pheasant nesting and brood production in various nesting cover types was obtained through intensive nesting habitat studies in 1958 and 1959, on a township-size area in eastern South Dakota. The study area lies within the State's prime pheasant range in a diversified livestock and corn-grain economy.

Nine broad categories of vegetation--strip cover, pasture, legumes, small grain, sloughs, flax, hayland, treeland, and idle farmland--were searched and nest histories recorded.

Oats, pasture, flax, and alfalfa were the principal cover types, comprising 75 percent of the nesting cover in 1958, and 70 percent in 1959.

Overall nest density was 0.84 nest per acre in 1958, and 0.91 in 1959. Highest densities were observed in fencerow and roadside strip-cover types, and in field-size blocks of alfalfa and sloughs.

Average hatching success was 20.0 percent of all nests in 1958, and 24.3 percent in 1959. The highest success was observed in small grain, flax, and railroad rights-of-way. Based upon the projected totals of hens and hatched nests on the 36 sections, it is estimated that 88 percent of all hens succeeded in hatching a clutch in 1959. Hen success data could not be calculated for 1958 for lack of reliable spring population estimate.

There was no significant difference in total production between years. Nearly 70 percent of the total production of young pheasants in both years came from small grain, pastures, sloughs, and roadsides. Less than average nesting density, but good hatching success was observed in small grain. More young pheasants were produced in small grain than in any other cover type.

The clutch size of hatched nests averaged 9.2 and 8.6 eggs, with 86 and 87 percent of the eggs hatched each year. Mean clutch size for all nests found was 8.3 and 8.0 eggs. The largest clutches and earliest nesting were observed in cover types where the greatest amount of residual cover occurred. Hatchability was highest for mid- and late-season nests.

No preference for plant species was detected in nest placement. Plant species occurred at nest sites in the approximate order of their abundance within each cover type.

The relative use and value of various nesting cover types for pheasant production has been determined for a portion of the South Dakota pheasant range. On lands devoted to maximum game production, alfalfa and clover should not be mowed; grasslands should not be grazed or grazed but very lightly; and small grain should be favored over row crops for the provision of cropland nesting cover. The benefits to pheasant production by delaying the mowing of roadsides should be impressed upon public road agencies.

S. Dak. Dept. Game, Fish, and Parks, Brookings, S. Dak.

Lyon, D. SAVE THAT COVER. Nebr. Outdoors 39 (5): 12-13. 1961.

Over half of 1961's potential fall pheasant crop will never be hunted. It will be lost and wasted, largely because of inadequate and insecure nesting cover. This has been proved by an intensive Nebraska Game Commission study in Clay and Fillmore Counties, which shows that only about 45 percent of the spring hen population will succeed in bringing off broods, even though each hen on the average renests twice after her initial nesting attempt fails.



Many factors plague the hen during nesting. In some cases, hens have nested up to six times without bringing off a brood. Too, predators and weather take their toll of nests. With better cover, fewer hens would be disturbed while nesting and weather or predators would not be as effective.

What man does with the land normally has a far greater effect on pheasants than any other factor. Harvesting wipes out cover, leaving the birds vulnerable to a host of pheasant killers. The farmer can enhance the status of ringnecks on his property by following proven practices beneficial to pheasants without affecting operations.

The peak of the hatch, often coincides with the peak of the first alfalfa mowing. While 30 percent of all nests are established in alfalfa, only 5 percent of the total chicks hatched come from this cover type. In addition, each spring about 15 percent of the nesting hens are injured or killed by the mower. Almost all of this nest destruction and crippling or death to hens occurs during the first cutting.

Of the total chicks on the study areas, 35 percent were hatched on roadsides. Any practices that reduce or destroy cover in these areas are extremely detrimental. Fall and spring burning and moving of roadsides are very detrimental practices.

Winter wheat is possibly the best pheasant nesting cover in Nebraska. This is true because there is so much of it and nests established in wheat are relatively free from predation and other disturbances. An average of 40 percent of all nests were found in this type of cover and 55 percent of all the chicks were produced here.

Hens also utilize fence rows and pastures. Some areas provide good cover, but generally they are poor in quality and do not give the security needed for safe nesting. Fence rows are usually too narrow and pastures are usually overgrazed.

Miscellaneous nesting types may be thrown into a single category called "unused". Abandoned farmsteads, pot-hole edges, and dry sloughs are examples. These areas often provide excellent nesting sites but usually are small in area. They have greater value as loafing, roosting, and winter cover.

Agricultural practices down through the years have steadily decreased the amount and quality of nesting cover. Land use will continue to intensify, but many practices can be modified so as to produce more desirable and less undesirable wildlife. One important land-use development has been the Conservation Reserve phase of the Soil Bank.

It is possible to assure greater production through sound land-use practices that all should follow. Ground cover protects the land as well as its wildlife. Winter and spring cover is especially critical. It shields both land and game through their period of greatest danger.

Game Biol. Nebr. Game, Forestation and Parks Comn., Lincoln, Nebr.

DeWitt, J. B., Menzie, C.M., Adomaitis, V. A., and Reichel, W. L. PESTICIDAL RESIDUES IN ANIMAL TISSUES. 25th North Amer. Wildlife Conf. pp. 277-285. 1960.

Tests upon penned animals indicated that quantities of DDT, chlordane, and heptachlor residues in tissues were roughly proportional to the degree of exposure to these compounds, and that the presence of more than 20 to 30 p.p.m. of DDT, 20 p.p.m. of chlordane, or 6 to 20 p.p.m. of heptachlor epoxide in quail tissues constituted presumptive evidence that the birds ingested the equivalents of lethal dosages of these compounds. Tests with starlings, rats, pheasants, and ducks indicated that these species differ in sensitivity to these compounds, and also may differ in their capacity to store residues in tissues.

Analysis of animals from areas that had been treated with heptachlor or dieldrin showed the presence of insecticidal residues in more than 98 percent of specimens found dead shortly after treatments were applied. Concentrations of

heptachlor epoxide in tissues of quail were comparable to those found in laboratory specimens known to have died as the result of heptachlor poisoning. Birds and animals shot on these areas 6 or more months after treatment contained insecticidal residues.

Bur. Sports Fisheries and Wildlife, Laurel, Md.

Smith, D. R. COMPETITION BETWEEN CATTLE AND GAME ON ELK WINTER RANGE. Wyo. Agr. Expt. Sta. B. 377, 16 pp. 1961.

The degree of competition between cattle and game in the Gros Ventre in Wyoming is a dynamic feature subject to much variation.

Competition existed in 1942 and it continued in 1957-1960. Current utilization data indicate that significant competition between the two types of animals is limited to herbaceous forage where use patterns overlap.

Some 21,000 acres of rangeland in the Gros Ventre have been set aside for winter elk use by administrative action of the U. S. Forest Service. This acreage is heavily used by the wintering game population.

Maximum allowable utilization of browse plants is regarded as 60 to 65 percent. Within the area of restricted livestock use, browse consumption is generally in excess of these limits although it varies with species, location, and time. Browse plants are currently in poor condition, and continued downward trend is to be expected under the existing game population. The herbaceous vegetation in this area is in fair or possibly low-good condition. Current use of this forage is excessive, and continued downward trends in range condition are to be expected.

Heavy forage utilization by game extends onto the cattle allotment in the area. Since cattle remove very little (less than 5 percent) of the available browse, the poor condition of browse plants within the cattle allotments is due to excessive game use. Heavy consumption of herbaceous forage by game extends onto the cattle allotments, especially the high, open ridges, and relegates livestock to a secondary position in determining range conditions.

Major concessions have been made in range use to favor the maintenance of game populations. These concessions have not been sufficient to prevent range deterioration, and additional management decisions are sorely needed. In order to maintain the concepts of conservation and multiply usage of public lands, it would appear that a reduction in size of the current elk herd is imperative.

U. Wyo., Agr. Expt. Sta., Laramie, Wyo.

### Wetland Wildlife

Anderson, H. G. FOOD HABITS OF MIGRATORY DUCKS IN ILLINOIS. Ill. Natural Hist. Survey B. 27 (4): 289-343. 1959.

In the autumns of 1938-40, duck gizzards totaling 4,977 were collected from hunting clubs and individual hunters at 21 sites along the Illinois River between Ottawa and Florence and 11 sites along the Mississippi River between Rock Island and Quincy in Illinois. The following 17 duck species were represented: mallard, pintail, green-winged teal, blue-winged teal, baldpate, gadwall, shoveler, black duck, wood duck, lesser scaup, ring-necked duck, redhead, canvasback, ruddy duck, greater scaup, common goldeneye, and oldsquaw.

The analyses indicated that, during the fall, most species of ducks in Illinois are predominantly vegetarians, that most of them feed principally on native wild plants, and that the lesser scaup is the only species with a diet predominantly animal.

Corn made up nearly half of the organic contents of mallard gizzards. Native wild foods were present in relatively greater quantities in gizzards of the wood

duck, pintail, redhead, baldpate, green-winged teal, and ring-necked duck, all of which included corn in their diets.

Of the 95 wild plants and 4 cultivated plants found in the gizzards and identified to species, the following 19 were most important: corn, rice cutgrass, marsh smartweed, coontail, wild millet, longleaf pondweed, water-hemp, nodding smartweed, buttonbush, large seeded smartweed, nut-grass, red-rooted nut-grass, chufa, Walter's millet, sago pondweed, duck-potato, river-bulrush, teal grass, and giant bur-reed.

The relative positions of the important food plants changed from year to year as accessibility and availability varied.

The importance of a plant species to a species of duck depended on the size of the duck and the type of feeding habitat frequented by the duck.

The dabbling ducks fed primarily on emergent and moist-soil plants and the diving ducks more frequently on submergent plants. Animal foods were more important to diving ducks than to dabbling ducks.

Snails and mussels provided the largest animal food volume and occurred in the largest number of gizzards. Insects were second in volume and occurrence.

Grit constituted about 11 to 28 percent of the gross contents of the gizzards of various duck species. Most of the stones were less than 2 mm. in size; the sizes ranged from minute to 19 mm. in size (largest dimension).

Ill. Natural Hist. Survey Div., Urbana, Ill.

Harmon, B. G., Thomas, C. H., and Glasgow, L. WATERFOWL FOODS IN LOUISIANA RICEFIELDS. 25th North Amer. Wildlife Conf. Trans. pp. 153-161. 1960.

The availability of waterfowl food was studied on the coastal prairie in southwestern Louisiana from November 1, 1958, to February 11, 1959. This is an important rice growing area and furnishes food for wintering waterfowl that feed on waste rice and weed seeds in harvested fields.

The total seeds found in rice fields in November samples amounted to 177 pounds per acre. Rice was the most abundant food for waterfowl. It was most abundant in total dry weight and in total volume. The average amount of rice per acre ranged from 142 pounds in November to 12 pounds in February.

The second most important food in the ricefields was wild millet. Red rice, brownseed paspalum, and signalgrass are good duck foods, but were present in small quantities. Plants of Cyperaceae, Polygonaceae, and Leguminosae families made up only trace amounts in the total food available for waterfowl.

A wide variation existed in the seasonal availability of food for waterfowl. The total amount of rice decreased from November throughout February by 92 percent.

Management measures suggested for the area are: (1) Ricefield flooding, (2) regulation of hunting and establishment of feeding and resting areas for ducks, (3) production and management of supplemental foods, and (4) land leveling practices.

La. State U., Baton Rouge, La.

Stoddard, C. H. WILD RICE PRODUCTION FROM NEW WETLANDS. 25th North Amer. Wildlife Conf. Trans. pp. 144-152. 1960.

Accelerated drainage of the remaining Minnesota and Wisconsin prairie marshes has become a vital issue in the conservation movement. The economics of profitable agriculture are driving swamp owners into drainage for crop production--thus converting areas of primary value for water and wildlife conservation into income-producing lands. The public is the loser in the long run, and the private owner the short run gainer.



Just to the north of the prairie-forest fringe areas are large open swamps--often with flowing streams through them--with poor soils and no agricultural values. Usually these grassy swamplands were covered with timber which was logged, followed by fire, and beaver flowages. They are of little value to wildlife since no open water is present and cannot be replanted to trees because of prohibitive costs. By flooding, they can be made into shallow lakes at low cost.

If the profit motive is driving central and southern wetlands of Minnesota and Wisconsin into drainage for crop production, the same incentive can be used to encourage development of wastelands both for wild rice production and conservation of wildlife in the North. Since 1955, a half dozen landowners in Wisconsin and Minnesota have created artificial impoundments of streams flowing through open brushy or grassy wetlands and have successfully demonstrated that it is possible to duplicate the natural conditions for wild rice growth and that a crop may be produced.

Soil and water tests in a number of these areas, which were once glacial lakebeds, indicate that very comparable conditions for wild rice production exist. Construction of low dams at necks of the swamps to impound flowing waters in shallow lakes creates areas suitable for wild rice production.

High prices for wild rice in recent years and the increasing popular demand for this food are such that an expansion in production should be a profitable undertaking by private individuals and public agencies. Further experimentation and research are needed to assure success before any wide-scale effort should be tried. Better plant strains must be developed through genetics to increase yields and obtain more even ripening.

Resources of the Future Inc., Washington, D. C.

Latimer, R. E. WOOD DUCK NESTING BOXES--CARE, CONSTRUCTION AND PLACEMENT. Pa. Game News 32 (4): 12-15. 1961.

Several types of wooden nesting boxes for wood ducks have been used by the Pennsylvania Game Commission over a period of years with varied success. Due to weathering effects and heavy predation, mainly by raccoon, a longer lasting and more predator proof box was needed. This has been found in the round galvanized metal box with conical-shaped top and oval-shaped 3" X 4" entrance hole. During 2 years, 100 percent occupancy was realized, with no losses by predation.

Better occupancy can be expected from the nesting boxes erected on steel posts over the open water than those erected in trees and on land. This also eliminates the squirrel, which is an important nest predator in some sections. It is advised that all boxes erected should be placed over water, using steel posts, on relatively stable bodies of water such as ponds, lakes, beaver dams, and marshes. Care should be used to select water areas where wave and ice action should result in little damage. Areas should be chosen that do not have a canopy of limbs overhanging the boxes from trees on the shore. The social nature of wood ducks results in their nesting close together wherever possible. The boxes may be erected as close as 30 feet to each other and as many as 8 or 10 in one area, providing a density of more than 1 box for every 2 acres of marsh is not exceeded.

Directions for making the boxes are given along with the proper erection and maintenance of them.

Waterfowl Mangt. Agent., Pa. Game Comm., Harrisburg, Pa.

Raccoon damage to waterfowl nests has increased as the raccoon population has increased. Examples are given of raccoon damage to nests of Canada geese, ground-nesting ducks, and wood ducks. Damage control efforts are summarized as follows: (1) Poisoned eggs have been used to prevent damage to Canada geese. (2) Preliminary trials have been made of artificial cylinders for nests for preventions of damage to mallards. (3) Wood ducks nesting in artificial structures have been protected by reducing the size of the box opening, by modifying the entrance by addition of a tunnel, by placing guards on the mounting posts, and by using other special methods for mounting the boxes. And (4) direct control of raccoons by poison.

Patuxent Wildlife Res. Cent., Laurel, Md.

## SUPPLEMENT

### Problems Indirectly Affecting Application of Soil and Water Conservation

Golden, A. M., and Jorgenson, E. C. THE SUGAR BEET NEMATODE AND ITS CONTROL. U.S. Dept. Agr. L. 486, 8 pp. 1961.

The sugar beet nematode stunts or kills sugar beet plants by attacking the roots. Infested spots in fields are conspicuous on hot days; tops of beets growing there wilt more readily than the tops of beets growing on uninfested soil.

Where fields are severely infested, many of the young beets wilt and die just after thinning.

In 1960, this nematode was known to occur in 14 of the beet-producing States: Arizona, California, Colorado, Idaho, Kansas, Michigan, Montana, Nebraska, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.

No commercial varieties of sugar beets are resistant to the sugar beet nematode, and infestations cannot be eradicated. After the pest is established in a field, the farmer's best defense is the use of crop rotations or soil fumigation to reduce nematode damage. Early planting also is helpful.

To control damage from the sugar beet nematode: (1) Prevent spread of nematodes into noninfested areas; (2) use a crop rotation designed to decrease the nematode population; (3) use nematocides, if practical; and (4) plant as early as possible and encourage early growth of the beets by maintaining a high level of soil fertility.

ARS, USDA, Inform. Div., Washington 25, D. C.

Hutchinson, M. T., Reed, J. P., Streu, H. T., DiEdwardo, A. A., and Schroeder, P. H. PLANT PARASITIC NEMATODES OF NEW JERSEY. N. J. Agr. Expt. Sta. B. 796, 33 pp. 1961.

A 5-year survey of New Jersey crop plants has shown that plant parasitic nematodes can be an important factor in limiting both production and quality. Since many of the samples were taken from areas where nematode damage was suspected, the survey probably does not represent New Jersey agriculture as a whole. The subtle nature of nematode injury and the ease with which it can be attributed to other causes, such as drought, winter injury, and lack of fertilizer, may help to balance the picture. A number of important crops, such as alfalfa, apple, the cole crops, and the cucurbits, need to be more adequately surveyed.

All the well-known types of plant parasitic nematodes have been found in New Jersey, but in comparison to nearby Maryland Pratylenchus and Hoplolaimus appear to be more abundant in New Jersey and Tylenchorhynchus, Helicotylenchus, and Xiphinema less abundant. Most cultivated fields surveyed showed the presence of at least one type of plant parasitic nematode; many contained more than one type. In any given field, severe injury is usually caused by only one nematode species and crop rotation may prove to be a practical control measure. In the less usual instances where injury is being caused by several different nematodes, crop rotation is usually not practical.

The fact that nematodes, such as the root-knot nematode, (Meloidogyne incognita acrita), the sting nematode (Belonolaimus longicaudatus), and the stubby root nematode (Trichodorus christiei), can maintain themselves around cultivated crops in southern New Jersey but have not as yet been found north of New Brunswick may indicate that the state spans two distinct bioclimatic zones: a southern "subtropic" and a northern "temperate."

Concerning stylet-bearing nematodes not known to be parasitic in New Jersey, the wide differences in abundance around the roots of different crops may possibly be explained by specific biological conditions around the root zones of these plants. There is always the possibility that an actual parasitic relationship will be demonstrated between these nematodes and the roots of higher plants, although the weak stylets of many of these species are apparently better adapted for piercing fungus hyphae than roots.

The preliminary survey of wild plants is useful in that it demonstrates that many nematodes found around cultivated plants are native to the State. Some of the wild plants are attacked by remarkably few parasitic nematodes; and, at a number of locations in northern New Jersey, no stylet-bearing nematodes of any sort could be found around several species of blueberry. Since plant parasitic nematodes are rather frequently associated with cultivated blueberry plants, it might be assumed either that the better cultural treatment given the cultivated plants encouraged populations of nematodes large enough to be detected, that some of the wild blueberry species are resistant, or that the nematodes found to be parasitic on blueberries in southern New Jersey do not occur in northern New Jersey. The same possibilities apply generally to other crop plants and their wild relatives.

N. J. Agr. Expt. Sta., Rutgers - The State U., New Brunswick, N. J.

Plant Pest Control Division. PLANT PEST DETECTION. U.S.D.A., Agr. Res. Serv. ARS 22-63, 8 pp. 1960.

This report discusses some of the aspects of plant pest control and shows how agricultural leaders generally can contribute to a dynamic detection program: (1) By being constantly alert to notice and report any unusual insect or pest activity, and (2) by encouraging farmers, foresters, livestock growers, outdoorsmen, Boy and Girl Scouts, 4-H'ers, vocational agricultural students, and others to do likewise.

ARS, USDA, Inform. Div., Washington 25, D. C.

Mankau, R., and Linford, M. B. HOST-PARASITE RELATIONSHIPS OF THE CLOVER CYST NEMATODE (HETERODERA TRIFOLII GOFFART). III. Agr. Expt. Sta. B. 667, 50 pp. 1961.

The parasitic relationships of the clover cyst nematode (Heterodera trifolii Goffart) in favorable hosts, in less favorable hosts, and in some highly resistant plants was studied. The objectives were to determine how this parasite enters the plant, how it obtains its food, how it injures the plant, and what kinds of plant responses are required for successful parasitism.



Living larvae penetrated the epidermis with some difficulty, and only after the stylet had been thrust repeatedly in a way that evidently weakened the outer wall. Once the head was within an epidermal cell, intracellular penetration into the cortex was rapid, the entire body often being inside within 15 minutes. Larvae were attracted to and entered through fresh wounds. They were seen to begin feeding only after entry into the root was almost complete.

Damage to young roots by larvae during penetration and intracellular wandering sometimes was extensive. If several larvae entered close together, they might kill a root tip. Such injury was not limited to host plants but occurred in roots of plants that were entered freely even though they were highly unfavorable for development of the parasite.

In a canners' strain of Perfection pea, the development of H. trifolii varied highly, many individuals dying early because syncytia became necrotic, some remaining stunted in association with slowly developed syncytia, while others were associated with adequate syncytia and developed as well as in Ladino clover. A continuous population did not develop in Perfection pea.

In red clover, some larvae continued to wander as long as 2 weeks. Most of the syncytia that were initiated developed slowly with inadequate dissolution of cell walls, and some of the small syncytia aborted, causing the parasite to die. A few normal parasites and syncytia did develop in red clover.

In tests of 27 varieties of soybean, a very few mature females of normal size were found in only 2 varieties. These were associated with small and chiefly abortive syncytia.

Both H. trifolii from clover and H. schachtii from sugar beet developed very well in spinach and were associated with syncytia that were similar to those described for Ladino clover.

H. trifolii was able to develop to maturity, although usually stunted, in individual plants of Lespedeza cuneata and yellow sweet clover. The larvae entered the roots of several additional dicotyledonous plants but did not enter the roots of the six monocots tested.

Regardless of which kind of susceptible plant was the host, the size of the female at maturity was closely related to the size of the syncytium, and the rate of development of the nematode depended upon the developmental rate of the syncytium.

H. trifolii and Meloidogyne hapla developed close together in roots of Ladino clover without either parasite appearing to influence the other. The syncytium of the one contrasted strikingly with the giant cells of the other even when the two types of pathological tissue lay in contact.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

Southern Cooperative Series. DISTRIBUTION OF PLANT-PARASITIC NEMATODES IN THE SOUTH. Southern Coop. Ser. B. 74, 72 pp. 1960.

Sixty-eight different species or genera of plant-parasitic nematodes in the South were found to be associated with at least 52 plant families. The nematodes found most frequently throughout the region belong to the genera Meloidogyne, Pratylenchus, Tylenchorhynchus, Helicotylenchus, Xiphinema, and Trichodorus in that order. Members of the genera Anguina, Ditylenchus, Radopholus, Belonolaimus, and Heterodera, as well as other genera, appear to have more localized distributions.

Over the region as a whole, the root-knot nematodes appear to be the most widespread. They are associated with crop decline more than any other nematodes. Observations over many years, along with numerous pathogenicity tests, leave little doubt that the root-knot nematodes cause great losses to crops. They probably constitute the principal nematode problem in the South as a whole. The number of plant species known to be attacked by the root-knot nematodes throughout the world exceeds 2,000. Outstanding cases of injury by these nematodes occur in the South to such important crop plants as tobacco, cotton, peanuts,

peaches, figs, sugarcane, clovers and other forage legumes, and to many vegetables including sweetpotatoes, tomatoes, melons, celery, spinach, okra, beans, peas, cucumbers, squash, and cabbage.

The root-lesion nematodes (*Pratylenchus* spp.) are widespread throughout the region and these nematodes probably are parasites of major importance.

Other nematodes now recognized as important include *Heterodera glycines* in parts of North Carolina, Tennessee, Arkansas, Mississippi, Kentucky, and Virginia; *Radopholus similis* on citrus and other crops in Florida; and *Belonolaimus* spp. on many crops in the sandier soils of the Coastal Plains from Virginia to Texas. Pathogenicity of various species of ectoparasitic nematodes has been proved on some plants under certain conditions and eliminated in others. In most instances ectoparasitic nematodes are still suspected plant pathogens.

Whether obvious pathological effects result may depend on the level of infestation, the physical environment, and the presence of other organisms, be they antagonists or facultative parasites acting as partners in a complex. The possible interactions between the host and parasite, as influenced by the associated biological and physical environments are many, resulting in numerous problems, most of which remain unsolved.

Tex. Agr. Expt. Sta., College Station, Tex.

Clore, W. J., Westlake, W. E., Walker, K. C., and Boswell, V. R. RESIDUAL EFFECTS OF SOIL INSECTICIDES ON CROP PLANTS. Wash. Agr. Expt. Sta. B. 627, 9 pp. 1961.

In 1950 varying amounts of DDT, BHC, chlordane, and aldrin were mixed in Sagemoor fsl to a depth of 6 inches. Effects on the growth of Abruzzi rye and Stringless Black Valentine snap beans grown in 1954 and 1959, Ranger alfalfa from 1955-58, and Blakemore strawberry plants in 1959 are presented.

During the fifth year of cropping, 15 lbs. of technical BHC was the only treatment that significantly reduced the yield of Abruzzi rye. Only DDT at the 24-pound and higher rates reduced the growth of the Stringless Black Valentine snap bean the same year.

Ranger alfalfa was grown for 4 years beginning 5 years after these materials were incorporated into the soil. No effects could be measured or observed.

In the tenth growing season after application, DDT at the rates of 119 and 238 lbs. technical, and 119 lbs. purified per acre reduced plant yields of rye and beans. Both rates of technical DDT reduced the plant yield of strawberries.

The apparent effects of DDT in reducing yields of specified plants are: (1) Rye--reduction of stand; (2) snap beans--severe stunting and more fibrous roots; and (3) strawberries--stunting and limited development of runners and fibrous roots.

Of the crops grown, Stringless Black Valentine snap bean was the most sensitive to DDT in the soil. The effect was so drastic that the crop was of no economic value where rates of 119 pounds of technical, or purified, DDT and 238 pounds of technical DDT were mixed into the soil 10 years ago.

Soil samples were analyzed 10 years after DDT was incorporated. The amounts of 9.9 purified, 24 technical, 119 technical, 119 purified, and 238 technical pounds per acre decreased 90, 89, 79, 67, and 73 percent, respectively. The small change in residue content during the last 4 years of this study indicates that DDT breaks down in the soil very slowly.

CRD, ARS, USDA, and Wash. Agr. Expt. Sta., Inst. Agr. Sci., Wash. State U., Pullman, Wash.

Dallimore, C. E. SOIL FUMIGATION WITH A TWO-BOTTOM TWO-WAY PLOW. Idaho Agr. Expt. Sta. 337, 20 pp. 1961.

Nematodes or eelworms can be controlled by soil fumigation. To be effective, very specific conditions must be met. The application must be of adequate quantity and properly made. Requirements for soil fumigation are:

1. Do not add manure or other organic matter when preparing land for fumigation.
2. The soil temperature must be at least 50° F. at a depth of 6 to 8 inches below the surface.
3. The soil moisture level should be ideal for tillage.
4. Apply the chemical 8 to 10 inches below the surface. In plow sole fumigation, place the chemical in the plow furrow ahead of the overturning soil. Use two outlets for plows cutting a swath of more than 12 inches.
5. Seal the soil surface in a separate operation by disking, harrowing, and rolling to remove large air pockets, break up clods, and compact the surface.
6. Allow a period of 2 to 3 weeks from date of fumigation to date of planting. Do not attempt to fumigate while plowing under alfalfa, clover, or grasses. For personal safety never work alone when fumigating soil.

The conditions for effective soil fumigation are given in this bulletin. Satisfactory control of these nematode pests can be achieved only by following them carefully. The parts necessary to convert a two-bottom two-way trail type plow into an efficient soil fumigator are described and suggestions are made for assembly.

Idaho Agr. Expt. Sta., U. Idaho Col. Agr., Moscow, Idaho.

Brugman, H. H., and Dickey, H. C. POTATO PULP AS A FEED FOR LIVESTOCK. Maine Agr. Expt. Sta. B. 599, 23 pp. 1961.

Potato pulp is the material left over after the starch has been removed from potatoes.

Wet potato pulp has approximately 94 percent moisture as it comes from the shaker. This can be reduced to about 79.5 to 83 percent moisture content. The potato pulp can be fed to cattle in the wet form as it comes from the press or centrifuge. The pressed wet potato pulp can also be passed through a drier and the moisture reduced to about 12.3 percent. A starch factory can produce approximately 8,750 lbs. of wet potato pulp (80 percent moisture) for every ton of starch.

The chemical analysis of whole potatoes, wet potato pulp, and dried potato pulp is as follows:

	Whole Potato Avg. %	Wet Potato Pulp Avg. %	Dried Potato Pulp Avg. %
Moisture-----	81.00	83.37	12.31
Protein-----	1.88	1.20	7.69*
Fat-----	.06	.06	0.39
Fiber-----	.58	1.06	6.14
Minerals-----	1.18	.51	3.20
Nitrogen-free Extract-----	15.30	13.80	70.27

\*The protein analysis of dried potato pulp from some starch plants may run as low as 5 percent.



Wet potato pulp is a palatable feed for cattle. The moisture content is sufficient so the animals do not require additional water. Feeder calves will require more additional protein than older cattle. All cattle fed wet potato pulp should have free access to calcium and phosphorus supplement (bonemeal) and trace mineralized salt including cobalt and iodine and fat soluble vitamins.

The pH will drop rapidly when wet pulp is stored until it reaches approximately 3.5. The acid formed acts as a preservative and the wet potato pulp will keep for extended periods in this condition. A source of vitamin A should be supplied when wet potato pulp is fed.

Dried potato pulp makes an excellent fattening feed for steers. All cattle will require free access to calcium and phosphorus supplement and trace mineralized salt. Dairy cows will eat dried potato pulp readily when it is fed alone. It is fairly bulky and not too dusty.

Dried potato pulp stands up well in storage because of its low moisture content. Under regular farm conditions, this feed can be stored as long as 1 year without any deterioration.

The dried potato pulp is high in sugar, low in fat, medium in fiber, and low in vitamins, particularly vitamin A. When fed with good quality hay and silage to make up for the vitamin deficiency, and when fed in grain mixtures containing adequate amounts of fat, dried potato pulp is a very satisfactory concentrate for dairy cows. Manufacturers add from 2 to 6 percent of molasses to the pulp.

A Comparison of the Digestible Crude Protein and Total Digestible Nutrients of Dried Potato Pulp and Other Standard Feeds

Feed	Digestible crude protein	Total digestible nutrients
Barley-----	10.0	77.7
Dried Beet Pulp-----	4.3	67.8
Dried Citrus Pulp-----	2.5	74.4
Corn Dent, U. S. No. 2-----	6.6	80.1
Hominy Feed, High Fat-----	8.0	84.5
Hominy Feed, Low Fat-----	7.5	81.4
Molasses, cane-----	0	65.2
Oats-----	9.4	70.1
Dried Potato Pulp-----	6.0	79.0
Wheat-----	11.1	80.0
Wheat Bran-----	13.7	67.2

Maine Agr. Expt. Sta., Orono, Maine.

### Radioactive Fallout

Reitemeier, R. F., and Menzel, R. G. EFFECTS OF A NUCLEAR ATTACK ON SOILS AND CROPS. U.S. Atomic Energy Comn., Tech. Inform. Serv. TID-5562, 10 pp. 1959.

Radioactive fallout deposited on agricultural land will contaminate food chains with radioisotopes by way of the soil and crops, and may, depending on the radiation intensity level, prevent farm workers from the proper handling of crops, and cause radiation injury to perennial plants such as trees and vines.

This technical report stresses the effects and behavior of fallout and gives recommended measures for the management of contaminated lands and crops.

\$0.14 from Off. Tech. Serv., Dept. Commerce, Washington 25, D. C.

Haghiri, F., and Sayre, J. D. SR-90 UPTAKE BY PLANTS AS INFLUENCED BY SOIL TYPES AND LIMING. Soil Sci. Soc. Amer. Proc. 25: 120-123. 1961.

A greenhouse study was conducted to determine the influence of various soil types and liming on the uptake of Sr-90 by plants. There were highly significant differences in the total uptake and concentration of Sr-90 by corn, soybeans, buckwheat, Sudangrass, and alfalfa from different soil types and liming. In general, the total uptake of Sr-90 from acid Ashtabula, Miami, and Canfield soils was considerably higher than the total uptake from slightly acid Brookston soil. Liming depressed the total uptake of Sr-90 by the plants grown on the acid Ashtabula, Miami, and Canfield soils; but had no effect on the total Sr-90 uptake by the plants from Brookston soil. These differences appear to be associated partly with the differences in exchangeable calcium and pH of the soils. The accumulation of radiostrontium by the various plant species after 5 weeks of growth was the order: Buckwheat > soybeans > alfalfa > Sudangrass = corn.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Sudia, T. W., and Linck, A. J. THE EFFECT OF pH ON THE ABSORPTION OF  $\text{Sr}^{89}$ ,  $\text{P}^{32}$ , and  $\text{Fe}^{59}$  IONS BY LEAVES OF ZEA MAYS. Ohio J. Sci. 61: 107-112. 1961.

The absorption and translocation of phosphorus-32, iron-59, and strontium-89 by the leaves of 10-day-old plants were studied as functions of pH. The pH of the solution in which the mineral ion is supplied to the corn plants had a significant effect on absorption. For the three mineral ions studied, greater absorption occurred at the lower pH values of 2.5 and 4.5 and significantly lower amounts were absorbed at the higher pH values of 7.0 and 8.2.

All three mineral ions are readily absorbed by the leaves of corn, but they differ markedly in the amount of each ion transported from the leaves. For the isotope of phosphorus, between 10 and 18 percent of the total activity in the plant is found in the stem and leaves following transport from the "applied leaf." These figures can be compared to from 45 to 67 percent of the iron translocated. Less than 2 percent of the radio-strontium was transported from the "applied leaf."

U. Minn., St. Paul, Minn.

Roberts, H., Jr., and Menzel, R. G. PLANT UPTAKE OF RADIONUCLIDES: AVAILABILITY OF EXCHANGEABLE AND NONEXCHANGEABLE STRONTIUM-90 TO PLANTS. Agr. and Food Chem. 9(2): 95-98. 1961.

Exchangeable and nonexchangeable fractions of strontium-90 were determined in soil samples taken from the plow layer of cultivated fields in the coastal plain of North Carolina in June 1955 and December 1958. Exchangeable strontium-90 contents averaged about 10 and  $50\mu\text{c}$ . per kg. of soil on the two sampling dates, respectively. Nonexchangeable strontium-90 contents averaged 4 and  $7\mu\text{c}$ ., respectively. Lower amounts of both fractions of strontium-90 were recovered in samples extracted after dry storage for 1 year. The uptake of strontium-90 and calcium from these soils was studied by growing cowpeas in the greenhouse. From 8 to 18 percent of the exchangeable strontium was taken up, depending on the uptake of exchangeable calcium. Use of discrimination factors to determine availability of nonexchangeable strontium-90 to plants is discussed. Nonexchangeable strontium-90 apparently made little or no contribution to uptake.

SWCRD, ARS, USDA, Beltsville, Md.

Tensho, K., Yeh, K., and Mitsui, S. THE UPTAKE OF STRONTIUM AND CESIUM BY PLANTS FROM SOIL WITH SPECIAL REFERENCE TO THE UNUSUAL CESIUM UPTAKE BY LOWLAND RICE AND ITS MECHANISM. Soil and Plant Food 6 (4): 176-183. 1961.

After harvesting the lowland and upland rice, wheat and broad bean were successively grown in pots on Tanashi soil, of volcanic ash origin, contaminated with Sr-90 and Cs-134.

Lowland rice showed an unusual high cesium uptake in comparison with the upland rice. It was found that Sr-90/Ca and Cs-134/K ratios were not necessarily identical in a plant body; and that, among the plant species, there seemed to be no remarkable difference in Sr-90/Ca and Cs-137/K ratios and their distribution factors, regarding their uptake from soil, except for the case of Cs-134 in lowland rice.

To explain the unusual high uptake of cesium by lowland rice, the following laboratory and seedling experiments were conducted mainly with respect to the specific properties of submerged soil resulted from anaerobic condition.

1. Three kinds of soils, one from upland and two from paddy field, were incubated with carrier free Cs-137 under upland and submerged soil conditions. The exchangeability of Cs-137 was markedly low in both soil conditions, and enough reduction in submerged soil seemed to accelerate its fixation by soil.

2. After shaking the suspension of Tanashi soil contaminated with carrier-free Cs-137 in the absence or presence of various kinds of salts and cesium carrier, its activity, not absorbed, was measured. The absorption of Cs-137 was retarded by the presence of salts, irrespective of the carrier. In the absence of the carrier, ammonium and especially rubidium ions behaved excellently towards this effect. The particular effect of these ions, however, was not significant in the presence of carrier. Further, in the absence of salts, the absorption was markedly decreased by the addition of the carrier.

It was suggested that the specific absorption mechanism of trace amount of cesium would take place in soil.

3. Mainly to confirm this specific ammonium and rubidium effects, a radioautographic experiment on Tanashi soil was conducted using various kinds of fertilizers and salts. The radioautographs showed that the Cs-137 was significantly moved by the presence of ammonium and especially rubidium salts, but no appreciable movement was found in the other cases.

4. A rice seedling experiment with a modified Neubauer technique was conducted regarding the effects of salts and carrier on the Cs-137 uptake from Tanashi soil. The uptake from the soil without carrier was extremely increased by the presence of ammonium and especially rubidium salts against the potassium salts which actively depressed its uptake, the absorption rates were 1.71 percent for rubidium chloride, 0.94 to 1.02 percent for ammonium salts, and 0.025 to 0.094 percent for the other cases. Meanwhile, due to the carrier addition, the uptake increased markedly especially in the absence of salts, but the specific effect of rubidium and ammonium was not found.

5. It was concluded that the reason for the unusual behaviour of lowland rice is predominantly due to the form of nitrogen source, ammonium in contrast with nitrate for upland crops.

Agr. U. Tokyo, Tokyo, Japan.

Spitsyn, V. I., and Gromov, V. V. ADSORPTION OF RADIOSTRONTIUM BY SOME SOILS AND SOIL MATERIALS. Soviet Soil Sci. 2: 1410-1414. Dec. 1959.

Adsorption of the radioactive fission product strontium was studied with 50 natural materials frequently found in soils, from solutions containing no extraneous cations and in the presence of stable strontium or calcium ions.



The greatest adsorption of radiostrontium was shown by the clay minerals (montmorillonite, kaolinite, halloysite) micas, hydrous micas, peat, pyrolusite, phosphorite, and nepheline syenite.

It was established that the ability of natural materials to adsorb radiostrontium strongly depends on a large exchange capacity. The presence of calcium, even as little as 100 mg./l, considerably reduces the adsorption of microquantities of strontium from solution.

Radiostrontium, filtering into groundwater, migrates easily and may enter man and animal organisms.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Schaeffer, O. A., Thompson, S. O., and Lark, N. L. CHLORINE-36 RADIOACTIVITY IN RAIN. J. Geophysical Res. 65: 4013-4016. 1960.

Cosmic rays and nuclear explosions are adding radioactivity to the atmosphere from which it is then removed by rainfall. The investigation of these activities furnishes a means of obtaining new information of significance in geological problems as well as in the understanding of the hazards of nuclear fallout. Chlorine-36 is an interesting isotope for such a study as it has a relatively long half-life, 308,000 years, and at the same time is very soluble in water. Relatively high levels of Cl-36 activity have been found in rain. The levels are several orders of magnitude above the level to be expected from cosmic-ray production. The Cl-36 is almost surely the result of neutron irradiation of sea water by nuclear explosions.

Chem. Dept., Brookhaven Nat. Lab., Upton, Long Island, N. Y.

Raja, M. E., and Babcock, K. L. ON THE SOIL CHEMISTRY OF RADIOIODINE. Soil Sci. 91: 1-5. 1961.

The relatively high amounts of short-lived fission products in local fallout, the increasing possibilities of reactor accidents, and the recent downward revision of the stratospheric residence time of fission debris, indicate that the soil chemistry of isotopes with short half-lives will be of importance.

Iodine-131, with a half-life of 8 days, is among these isotopes.

The behavior of carrier-free I-131 in two California soils in two clay minerals and in peat was studied. The result of pretreatment by autoclaving, oxidation with peroxide, and digestion with alcohol, as well as extraction of I-131 with various salt solutions, all indicate that the large fraction of I-131 retained by the soils is due to reaction with organic matter.

U. Calif., Berkeley, Calif.

Wasserman, R. H., and Comar, C. L. ANNOTATED BIBLIOGRAPHY OF STRONTIUM AND CALCIUM METABOLISM IN MAN AND ANIMALS. U.S. Dept. Agr. Misc. P. 821, 135 pp. 1961.

Within recent years, it has become necessary to understand the metabolism and movement of radioactive strontium in the biosphere. The behavior of strontium in man and animals is closely linked with that of calcium, and it is necessary to consider the factors that govern the behavior of both elements. Many subject areas are involved either directly or indirectly; for example, nutrition, bone physiology, gestation, lactation, vitamin action, and hormone action. This is apparent from the vast and frequently confusing literature on calcium itself. It is very difficult for an individual or a research group to acquire an integrated and adequate background for the study of strontium and calcium metabolism.

This annotated bibliography was compiled and systematized to provide a ready source of pertinent published material and to call attention to important peripheral subject areas. It should be useful to national defense workers who are doing research on the strontium-calcium relationship. No attempt has been made to cover the literature exhaustively. Representative references have been included so as to indicate the present status of knowledge of, and the relationship of pertinent subject areas to, strontium and calcium metabolism.

The abstracts have been classified by major category and arranged alphabetically by author.

ARS, USDA, Inform. Div., Washington 25, D. C.

Bickers, J. WHY FARMERS DON'T NEED TO FEAR FALL-OUT. Farm J. (Eastern Ed.) pp. 26-27, 50. Dec. 1961.

Even in a massive, all-out attack, three out of four farmers wouldn't get enough fall-out to keep the farmer indoors continuously more than 1 day.

The farmer would need the equivalent of a basement-type fallout shelter, and he would have to limit his outside activities to just a few hours daily for about 1 week.

A farmer so close he could see the fireball would still have an hour or so before the fall-out sifts down.

Most radioactive isotopes produced in an atomic explosion decay rapidly. After 7 hours, radioactivity has fallen to 1/10 the original level; and the decline continues.

The first concern would be the family. Chances are good that they'd be safe right in their own basement, if it has no windows or doors above ground or if the window openings were closed with sandbags. A completely enclosed basement under an ordinary two-story frame house cuts radiation to one-tenth.

The next concern would be the livestock. He could protect them against all but the heaviest fall-out simply by driving them into the buildings and closing the doors and windows. A big frame barn with 25 feet of baled hay cuts fall-out to one-fifth or less.

Once the fall-out had arrived, it would be a matter of waiting under shelter until radioactivity had reached a safe level. If the farm was showered with dust at 100 roentgens (r.) an hour 1 hour after the attack, the farmer would need to wait inside a shelter for only 3 hours. The it would be safe to stay outside for about an hour. Even if he got 300 r./hr., it would be safe to go out for emergency chores after 7 hours.

Since any radiation is bad and may shorten your life, one shouldn't go out any longer than necessary until the level has dropped to 1/2 r./hr. Civil Defense officials are advising that a person shouldn't be exposed to more than 30 r./hr. the first day, no more than 200 r./hr. the first week, and no more than a total of 1,000 r./hr. within 1 year's time.

If the farm was that one farm in four that might get 1,000 r./hr., the farmer would need to stay inside for 2 days before venturing out. On the 8 percent of farms that might get mammoth radiation of 3,000 r./hr. or more, people could still survive, if they had a shelter of the type you've been reading about in the daily newspaper. Many farms already have a cyclone cellar or a potato cellar. Covered with 3 feet of dirt, such a cellar cuts even the heaviest amounts of fall-out radiation to a safe level.

Scientists have estimated that half the people exposed to 450 roentgens for an hour will die sometime within 30 days. Those getting over 200 roentgens would suffer from radiation sickness.

University of Tennessee scientists have calculated the total dose it takes to kill animals: cattle, 550 r.; burros, 585 to 784 r.; sheep, 525 r.; hogs, 618 r.; and poultry, 900 r.

Staff Writer, Farm Journal, Philadelphia 5, Pa.







